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GLASS STANDARDS OF WEIGHT AND VOLUME IN EIGHTH CENTURY EGYPT

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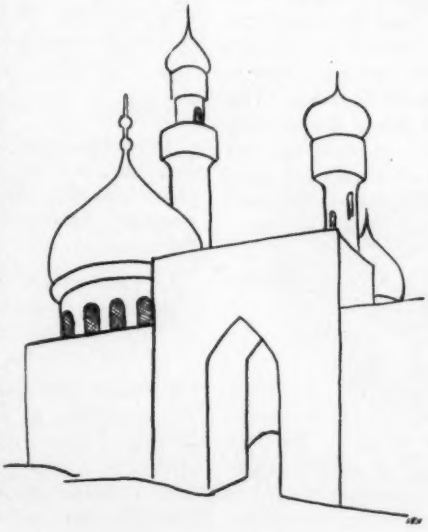
PART I

"Early Arabic Glass Weights and Stamps" by George C. Miles, *Numismatic Notes and Monographs*, No. 111 (1948), published by the American Numismatic Society, New York, contains a catalogue of over 200 examples of early 8th to middle 9th century A. D. inscribed Arabic glass weights and stamps that are in the Society's collections. Most of the material in the introduction to this present paper is taken from Dr. Miles' introductory essay, pp. 1-29 of the monograph, "The types, epigraphy and metrology of early Arabic glass weights and stamps." The main portion of this paper is based on my essay in the monograph, pp. 31-69, "The manufacture of eighth century Egyptian glass weights and stamps." I am indebted to Dr. Miles and the American Numismatic Society for permission to use this material.

Introduction

The Arabs had a unique use for glass—to manufacture standards with which to check the constancy of weight of metal coins. Clipping coins to reduce their weight and the use of alloys to debase the coinage were widespread practices in late Byzantine times (around 600 A.D.) for the late Byzantine emperors were always in need of money. "The clipping of coins", says Miles, "has of course been a common practice from the earliest times until the introduction of modern collars and milling and thus coins were more frequently accepted by weight than by number. The glass weight enabled the merchant or money-changer to establish with remarkable accuracy whether a coin was up to standard. Debasement was another factor which could be established by the weights."



Glass check-weights were probably first used in the Byzantine Empire. When the Arabs progressively conquered Byzantium,* they retained for a while many of its governmental forms in Syria and Egpyt, including the system of weights and measures. The currency reforms introduced by the Arabs in order to standardize values included the use of glass weights as standards and official glass stamps affixed to glass containers used for measures of volume. By 700 A.D. glass weights and vessel stamps were being manufactured in Egypt in an official government bureau and were inscribed with the names of the governors who authorized them as well as with other data. As historical records contain the names of these officials and the years of their government service in Egypt, it is possible to date the inscribed glass very accurately and to know that these weights and stamps were made in Egypt, probably in one shop.

Government financing through taxation was well perfected, and at least one Caliph, al-Walid (705-715 A.D.), exhorted his tax collectors to "Milk till the udder be dry, and let blood drop to the last drop."

* The establishment of Arab rule in the Near East, the eastern Mediterranean and in Spain marks the final destruction of the Roman Empire and the cultural and economic beginning of the Middle Ages. From 750 to 1250 A.D. the Arabs were the cultural leaders of the western world, producing major developments in algebra, astronomy, art, medicine, and philosophy, and serving as conservators for the western world of ancient Greek science and philosophy.

Bureau of Standards

A fifteenth century writer, Maqrizi, described the Bureau as it existed in Cairo at that time. Its functions were doubtless very similar to those of the same Office in the eighth century. Miles' translation of this report is as follows:

"There was for the control (of weights and measures) a place known as the *Dar al-Ayar* in which all the scales and weights were tested. The Imperial *diwan* supplied everything that was necessary for this bureau, such as copper, iron, wood, glass, and other equipment, and also hired craftsmen, supervisors, and the like. The inspector of weights and measures, or his deputy, went to this bureau so that everything that was made there could be tested in his presence. If they were made correct, he certified them; and if not, he ordered them to be remade until they were correct. There were in this bureau patterns for testing the accuracy of the standards; and weights, scales and measures of capacity were not sold anywhere except in this bureau. All the merchants when summoned by the inspector of weights and measures came to the bureau with their scales and weights and measures for immediate testing. If any were found deficient they were taken up by the bureau from the owners and destroyed; and the owner was required to buy others that were accurate and to pay for them . . ."

Fig. 1. Top to bottom: Blue-green, 737 AD, 33mm. diameter; (left) Obverse, and (right) Reverse, pale green, 759-760 AD, 22mm. diameter; Amber, 775-778 AD, 20mm. diameter; Dark blue, 808-810 AD, 30mm. diameter.

Sample

When Dr. Miles was preparing his monograph, he asked me if I would analyze one of his coin weights on which the legend was too blurred to be of any value, so that the piece could be destroyed if necessary. I was glad to do so but requested that he lend me a representative series of eighth century glass stamps and weights for testing so that a general study of the glass used in this Arabic Bureau of Standards could be made. This he most kindly did, sending me 16 pieces dating from 709 to 810 A.D. Thus it was possible to study and test 16 pieces made within a limited period of time and space and then to decide whether the group was sufficiently homogeneous to justify the work of a complete chemical analysis.

The materials studied were of four types: coin weights, disk and ring weights, and vessel stamps.

Coin Weights

These are disks of glass with an inscription pressed into one or both faces with an iron stamp, leaving a raised rim of glass around the edge (Fig. 1). The size of the coin weights varies with the type of coin for which they were used as standards, and ranges from 19 to 32 mm. in diameter and 1.4 to 5.8 grams in weight. They are approximately 3 mm. thick at the rim and 2 mm. in the center. Dr. Miles has found that the glass coin weights agree very well with the theoretical legal values for the several types of coins.

Disk Weights

These heavier weights were used for ounces, fractions thereof, and at times for fractions of pounds. They are plano-convex oval to roughly circular disks of glass on which a stamp bearing the inscription has been sunk in the convex surface. Typical disk weights range up to 63 mm. in diameter and 19 mm. in thickness. (Fig. 2)

Ring Weights

These weights were used for a pound and its multiples. They are somewhat doughnut-shaped with flattened sides with one or more stamps on the top surface and on one of the sides (Fig. 3). They are approximately 60 x 40 x 30 mm. in size. Miles believes that the hole in the center was to enable merchants to suspend the weight on the scales, or was used for storage on a peg or hook.

Vessel Stamps

These are similar to the stamps on the shoulders of liqueur and brandy bottles. They are much like the coin weights, only larger, and were applied near the rim to the walls of glass cups and bowls certifying them as standard measures for certain products. Miles suggests that some of these bowls "were used by tax-collectors and their deputies in the bazaars for the measuring-out of tax payments in the form of oil, honey, vinegar, etc." The vessel stamps range in diameter from 29 to 43 mm. One bowl rim fragment was large enough to measure; its rim diameter was 70 mm. (Fig. 4)

Inscriptions

The inscriptions appearing on these four classes of objects have a pious statement, the name of the governor (by which they can be dated) and an indication of the measure. An example which includes a quotation from the Koran is:

Of what ordered the servant of Allah,
Abdullah, Commander of the Believers:
"Give just measure and be not among the defrauders."
One-half *qist*, full measure.

(A qist is a liquid measure, roughly equivalent to a pint.) The remainder of the Koranic quotation which appears on some stamps is, "Weigh with a just balance and diminish not unto men any of their possessions." Another common inscription is "Honesty to Allah." Many legends specify not only the amount but also the type of

material, such as olive oil, meat, ointment, polished lupines, shelled lentils and pease, red and white sesame seeds, chick-peas and dates.

Appearance of the Glass

The glass weights and stamps in this collection came from the vicinity of Cairo. Some were excavated by archaeologists while others were purchased from antiquity dealers who had obtained them from local Arabs. Most of them were buried for at least a thousand years in the soil of Egypt but are well preserved because of the dry climate. (The average annual rainfall at Cairo is 1.27 inches.) Some of the objects are chipped or broken, as can be seen from the photographs, but many are surprisingly complete. Almost all of them have been carefully cleaned since being found, so there is little soil which might give a clue as to the region of burial clinging to the glass. There are few weathering flakes on the surfaces, perhaps because of energetic cleaning.

Blue-green, dark blue and amber colored glasses were among the sixteen pieces studied, the color distribution being 13, 2, and 1. Blue-green is the dominant color, varying from a pale green-gray in thin coin weights to a very deep green in the thick gobs of glass used to form the ring weights. While much of the color range is due to variation in the thickness of the pieces, some of it is caused by the amounts of copper, iron and manganese in the glasses.

The deep blue coin weights have copper as their major colorant, but spot tests show that a trace of cobalt is also present.

The few amber coin weights that date from the late eighth century A.D. are of the same general composition as the blue-green group, if the index of refraction and apparent specific gravity of one small coin weight may serve as a guide. Excess carbon or sulphur in the glass could account for the color.

Most of the stamps and weights showed little evidence of weathering when examined visually; however, several of them were seen under the binocular microscope to have finely pitted surfaces in which were trapped a few irridescent flakes and some clay. Most ancient glass has a light tan to white laminated surface patina when it is unearthed, and below this is a flaky irridescent layer that is quite attractive in appearance. When both of these layers are removed the dull pitted surface of the glass in its original color is exposed. Since the stamps and weights were doubtless cleaned in recent years, the degree of weathering can be judged only by the amount of surface pitting. Seeds breaking at the surface of the cooling glass and abrasion due to wind and water action must be differentiated from pitting caused by chemical weathering. It may be significant that the pieces showing microscopic traces of weathering all dated from the first half of the eighth century, with one exception, while the glass made later in the century retained its lustrous surface. This could be due to slight compositional differences, but the chemical nature and moisture content of the soil in which the glass was buried could greatly affect the degree of weathering.

The coin weight originally submitted by Dr. Miles for analysis because its inscription was illegible was quite pitted. A light blue ring weight had a badly spalled irridescent surface on which no trace of an inscription remained. The former was analyzed chemically and will be discussed later. Both of these pieces differed from the rest of the series in index of refraction and apparent specific gravity.

Inhomogeneities were common in the glass. The seeds varied from pin points to bubbles 3 mm. in diameter, most being less than 1 mm. in size. Many of the coin weights and vessel stamps contained only very fine seeds, but the ring weights, formed from larger gobs of glass, were coarsely seedy. A few stones with rounded surfaces occurred in the ring and disk weights and ranged in size from minute specks to 4 mm. in diameter. Those that could be tested were undissolved quartz. Cords with entrapped seeds and streaks discolored by dissolving iron scale were common in the larger pieces. Iron scale adhered to the lower surface of the coin weights and was occasionally seen at the base of the letters in the inscriptions. A few flakes were in the body of the glass.

Fabrication

Conclusions based on the study of 16 specimens have not the surety that would result from an examination of a much larger group, but these 16 pieces, selected as representatives by Dr. Miles, give many indications as to how the stamps and weights were made. They are sufficient to suggest a broad picture of the processes. In the following discussion, the conclusions (printed in italics) are followed by a statement of the supporting evidence.

Fig. 2. Top to bottom: Blue-green, 754-775 AD, stamp 35mm. diameter, piece 63mm. diameter; Blue-green, 775-778 AD, 19mm. diameter, piece maximum diameter 38mm.

Fig. 3. Top to bottom: Blue-green, 737 AD, stamps are 17 and 23mm. diameter; (left) yellow-green, 762-769 AD, 28 and 43mm. diameter and (right) dark green, 775-778 AD, 21 and 31mm. diameter; left and right (side view), opaque, striated red, brown, very dark green.

Coin Weights

A button of glass was poured from a crucible or ladle onto a flat iron plate. Iron scale in flakes up to 2 mm. in diameter occurs on the flat reverse surfaces, thus indicating close contact with iron. The iron was checked chemically by the potassium thiocyanate test. A relatively large deposit of iron oxide on the back of the coin weights, some of it folded into the glass, was picked up by the first—the hottest—glass to touch the plate, for hot glass will stick to cold iron. This iron deposit is quite marked on the back of the coin weights. The seeds, iron scale and streaks formed by dissolving iron tend to be concentrically distributed. This would result if the glass were poured in pyramidal fashion at a spot on the plate. The large number of iron flecks that appear within the weights, some of them even having been in the glass long enough to start dissolving in the form of yellow-green streaks, suggests that an iron ladle had been used to handle the glass. The ladle, through use, would develop an oxidized crust that would tend to scale off when coming in contact with hot glass.

An iron die was then pressed against the disk of hot glass to produce the inscription. A careful examination of the inscribed surfaces under a microscope shows iron scale on the surface at the base of letters, in open areas on the disks, and down in the glass just below the inscription, where it has begun to dissolve.

The die was carefully centered over the gob of glass before pressing. The raised ring of glass around the edge of the weights is uniform in size. However, the disks are sufficiently irregular in shape to show that they were not cast in depressions in an iron plate. Surface tension will cause gobs of hot glass to try to assume a round shape on a clean, flat surface.

The precision attained in manufacturing these glass weights, $\pm$ 1% or less for the smaller weights, is an indication of the skill of the eighth century glass makers. On any repetitive process such as ladling out a small amount of glass into which an inscribed iron stamp is pressed, it is possible to obtain sufficient dexterity so that almost identical amounts of glass will be used for successive stampings. One is always impressed when watching skilled glass-workers by the ease with which they gather exactly the right amount of glass to form a handle or an ornament. In modern optical glass manufacture, the operator at the glory hole must shear off exactly enough soft glass from a cylinder that he has been shaping in a flame to exactly fill a mold into which the glass is pressed. There is no reason why earlier glass makers could not attain the same skill, particularly if they used a small ladle with which to dip out exactly the right amount of glass.

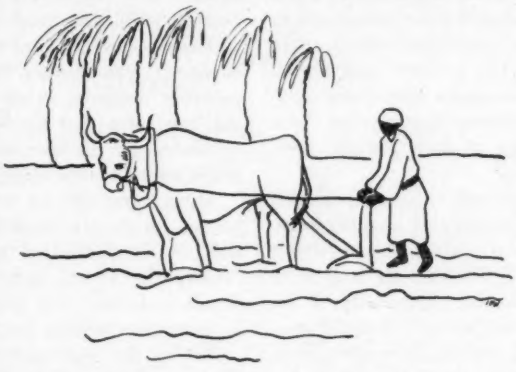
Glass weights are relatively cheap to make and can be prepared in large quantities, so it would be quite feasible to weigh the weights after manufacture and to reject those that differed from the standard. Such discarded pieces could be remelted as cullet and reshaped.

Fig. 4. Left, 729-730 AD, blue green, 43mm. and Right, 739-740 AD, blue-green, 40mm. (part of vessel wall can be seen).

Skill in manufacture and the low cost of rejection of sub-standard weights would seem to account for the consistency in measurement of the weights that has been found.

Vessel Stamps

A gob of molten glass was ladled or poured onto the red-hot and still plastic wall of a glass vessel at or just below the rim. The inscribed stamp was then pressed on the hot glass while the interior of the wall at the spot where the impression was being made was supported to prevent deformation. There are only four vessel stamps in the collection studied, so these statements may have limited application. The stamps were not formed separately and then attached to the vessels, *i.e.*, made by the coin weight technique, because none of the stamps had the prominent iron deposit on their reverse that is characteristic of all of the coin weights in the group. At the stamp-vessel interface there are several large bubbles which suggest air entrapment when the two pieces were joined. There is an oval lozenge-shaped projection on the interior of the vessel wall behind the stamp which indicates that the support during the time of pressing had a sunken area into which the glass flowed under pressure. This technique would more or less rivet the stamp to the wall and the union would be much stronger than if two flat glass surfaces were pressed together when still soft. None of the four lozenge surfaces show any trace of iron scale, so there is no evidence as to the form of support used to back up the wall. It is possible that a tong-like mold was used. Mr. Robert J. Leavy of the Steuben Glass Company examined the complete series of vessel stamps in New York. He suggests that the bulge is the result of the natural sinking of the vessel wall at the hottest point when the stamp is applied.



Disk Stamp

The disk stamp examined appears to have been made by the same technique as that used for the coin weights. It is fragmentary but originally was about 8 cm. in diameter with an inscribed central depression 4 cm. in diameter. The outer ring of glass is 2 cm. thick. On the base of the disk the glass shows many folds indicative of the way in which it was poured to form this large disk. There is an iron scale deposit about 3 cm. in diameter near the center of the base. A large amount of glass was needed to form this stamp and most of it is of poor quality, full of seeds, stones and cords. The glass was probably quite viscous when poured.

Ring Weights

The three specimens examined are too fragmentary to permit detailed reconstruction of the techniques used in forming them. A strip of glass could be bent into shape around an angular core and then impressed with the stamp. Mr. Leavy suggested that the glass was gathered on a punty and shaped around a wooden rod, which was then removed. One of the ring weights which I did not see bears a punty mark on its base. As with the disk stamp, large quantities of glass were used, so quality suffered. There is every indication that the glass was not heated at a temperature high enough to eliminate the bubbles and other inhomogeneities and dissolve all of the stones.

Physical Properties

Composition changes affect both the index of refraction and specific gravity of a glass. These properties together can characterize glasses, but either used alone may give a false picture of the uniformity or dissimilarity of a group of glasses. The index of refraction is readily determined without injury to the specimen and the specific gravity can be approximated by measurement of the apparent specific gravity.

The index of refraction of each of the Arabic glasses was determined on a minute sample scratched from the back of the weights and stamps with a tungsten carbide marker. In order to get the true index of the glass, grains were removed from an area on the surface near which no iron scale adhered or dark green streaks appeared, for an increase in the iron content of a glass would raise its index. Weathered areas were avoided. In doubtful cases the index was checked at several spots, preferably on surfaces that had been chipped. Cords and striae were common and had to be distinguished from the matrix when making index determinations.

The glasses varied in index of refraction in white light from 1.511 to 1.529 as is shown in Table I. The brown patina on the two weathered specimens had an index lower than 1.48.

The true specific gravity of glasses can be approximated by loss of weight in water on small pieces that contain no seeds or stones when it is impossible to crush the samples. The Arabic glass was quite seedy; it had a few stones and variable amounts of iron scale trapped on the surface and included in the glass, and the museum specimens had to be preserved. Therefore, only the apparent specific gravity was determined, with results ranging from 2.327 to 2.560, as is shown in Table I.

An analysis of the data in Table I suggests a division into five groups.

A) Ten of the blue-green pieces are alike in index of refraction, 1.512, but range in specific gravity from 2.430 to 2.494. They are listed in order of increasing weight. The degree of seediness tends to increase with the size of the piece, and stones occur only in the three largest specimens. The specific gravity is greatest in the smallest, most seed-free pieces, as would be expected. The value of 2.494 for a two-gram coin weight probably approaches the true value for the glass.

B) The one amber coin weight tested is like Group A in index but is slightly denser, 2.512. It is probably

(*Continued on page* 516)

MORE ABOUT THE EROSION FURNACE

By GEORGE E. HOWARD, Consulting Engineer
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In a series of three articles published in THE GLASS INDUSTRY in November and December, 1948, and in January, 1949, I made a critical analysis of glass melting by the conventional tank furnace. The criticism was directed to the tank as a structure and to the cycle or process employed therein. The faults in engineering and operation were well known and that portion of my presentation was confined generally to a summary of the principal faults inherent in the system, which though incurable had through the past fifty years been somewhat mitigated by controls, refinements, and other palliatives at a tremendous cost.

The second and third installments were directed primarily to the thesis that finality of concept of both structure and process was largely traditional and historical; that research and development in glass and refractories would enable us to break out of this rut and evolve a better structure and process. I indicated two directions or leads with illustrations showing principles which could achieve the desired purpose. The written and verbal comments received were so numerous and from such wide spread areas, the United States, Europe and Asia, that I was able to get a fair idea of these average reactions.

To digress, I suggest that anyone interested in this subject might re-read the former articles to advantage. The interest centered mainly in a proposed furnace which I called "The Erosion Furnace." This article is a more detailed description of this concept. Originally, I intended to merely set out the principles which could provide a basis for a practical development. Obviously, such illustrated sketches as were shown provided certain basic principles, but were not intended as engineering structures, and this was so stated. Notwithstanding that limitation, there was considerable interest and the general attitude was that the process would improve the melting process *if* a practical structure could be devised to carry it out.

Usually this *if* was accompanied by problems and difficulties superficially apparent in the illustrations when they were considered as final engineering designs, which they definitely were not, instead of illustrations of principles only.

This attitude was exemplified by the following conjectures: 1) Some feared that the furnace would clog up. 2) Others feared that the opposite effect would ensue and the batch would run through without being plained or finished. 3) Others feared that a flue or hot path would develop as sometimes occurs in shaft lime kilns. 4) Others feared the glass would channel and stratify. 5) Others feared that if silica lumps which act as a sort of filter bed were used they would dissolve to a small size and work out into the glass as lumps instead of sand or stones. Numbers 1, 2, 3 and 4 definitely do *not* present any major problems. Number 5 is a minor problem, the cure for which will be detailed later in connection with the description of the sketches.

Since the publication of my previous articles, considerable information has been received that probably would not have been available otherwise. There have been several experimental furnaces tried out and, in one case, certain parties are now operating their third furnace which is of commercial size. Also I have learned that others are planning to try out certain radical melting units.

The old adage "necessity is the mother of invention" applies aptly to this situation. The glass industry is ancient, conservative and full of traditional inhibitions which tend to obstruct progress. Take the container business as an example, and consider the time-honored beer bottle. At one time I hammered at the conventional beer bottle idea for years without making a dent. The basic idea seemed to be a half-inch bottom so that the drinker at the bar could pound for attention for a second bottle without too much breakage.

The unnecessary high cost of an 8-oz. drink in a 15-oz. container was another "must." Also the bottle was apparently designed to tip over easily. Quite absurd was the fixed idea that the long swelled neck was necessary to distinguish the beer bottle from some other bottle that might contain some other fluid.

Along came the tin beer can and overnight the thick bottom, expensive shape suitable mainly for tipping over and the long swelled neck disappeared as essentials. Finally the short, light, neckless, bottle and now the One-Way bottle were evolved. The same thing is going on now with the milk bottle.

During the war and the paper shortage, glass milk bottles enjoyed a field day, but the holiday is over and the glass milk bottle must now get busy to keep on the map. Slogans will not be sufficient to produce a satisfactory volume. The slogan "See what you buy, buy in glass" was clever and no doubt helped certain quality products, but even this proved a two-edged sword.

The glass package's competitor, cellophane, devoid of traditional inhibitions certainly "took notice" and proceeded to build up a large business, packaging about everything from prunes to shirts. Most of this development was not applicable to glass, but much that was should have been developed for glass. All of this is important because cost is a rational basis for product volume. Neither slogans nor traditions will help much. The cost of melting glass in tanks is the largest single item of cost amenable to drastic improvement. This cost can be cut radically but not without at least some effort, expense and the trial of some proposal.

Merely to fear some imagined difficulty will accomplish nothing. It would be more rational to at least find out if such a difficulty really exists rather than only imagined. Even if it is found to exist, still the rational attitude would be to determine its importance and whether or not it can be eliminated. To further aid those who may be interested in the Erosion Furnace, I am submitting two designs of this type of furnace.

The first design shown by Figs. 1, 2, 3 and 4 is for a furnace in which the heat receiving surface for melting and plaining consists of lumps of special silica brick which are available as "bats" at a low price per ton. This material has a low specific gravity considerably less than that of molten glass. It has a low percentage of iron and is highly resistant to erosion and will permit decolorizers to produce white or flint glass even if the erosion or solution of the filter bed is many times the amount estimated. This estimate is calculated on data arrived at by both theoretical and actually demonstrated experimentation.

It is probable that some percentage of the lumps will eventually erode to a small enough size to pass through the interstices which provide passage for the products of combustion upwardly and the passage of glass downwardly. These small eroded lumps will float with a high degree of buoyancy. It is desirable to provide suitable means to prevent these small lumps from passing into the working end, feeders or other fabricating portions. Even if such means were not provided and assuming that all the large filter bed lumps eventually eroded and passed into the working end, the result would be insignificant.

On the basis of an 8-oz. container, the loss of pack would be a small fraction of 1 per cent. Even this small amount would be reduced through the "Poisson Series Law" which operates in such cases. However, practically complete removal can be accomplished through means shown in Figs. 1, 2 and 3 which means are well known to anyone familiar with practical glass melting operations.

HOWARD-EROSION-FURNACE.

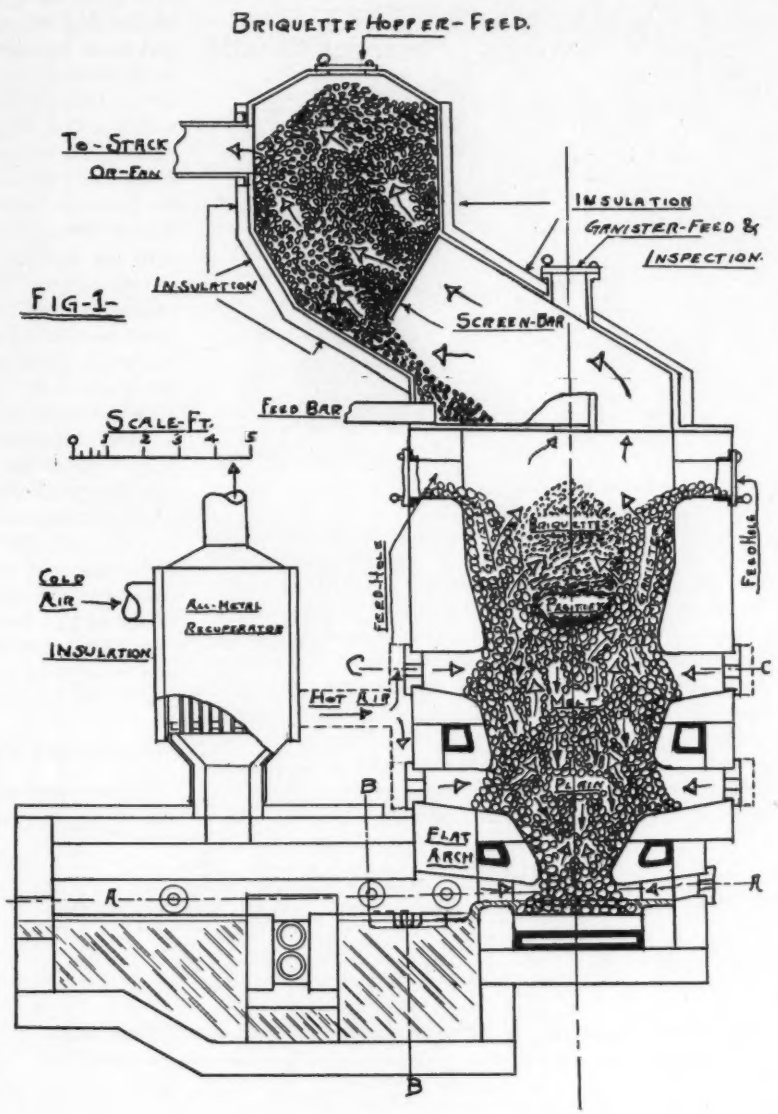
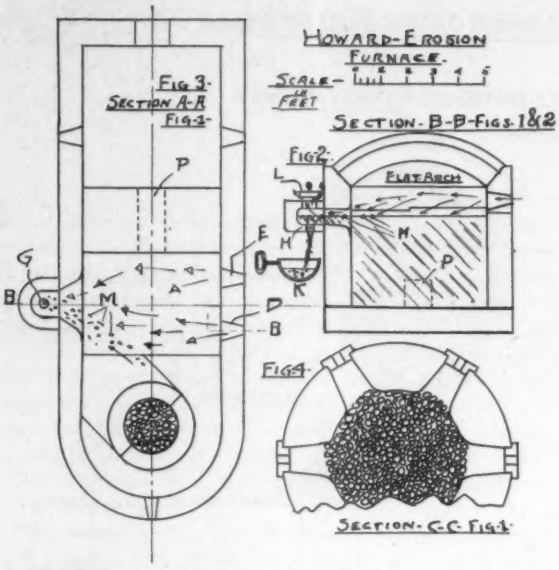


FIG-1-

The glass passes over a lip in the accumulating basin in a thin stream probably 1/16" thick and such eroded silica lumps that would pass would be driven by the high velocity burners E & D, Fig. 3, into the dribble chamber H, Fig. 2, and by intermittently or continuously tapping off a small amount, the lumps would be removed and used again in the batch. The surface current created would assist this action and would provide a controllable metal line level stabilizer for periods when the load on the tank was changed. The metal line level in the conventional tank during load change takes a relatively longer time. In both the conventional tank and the herein proposed Erosion Furnace, the load would be exactly equal to the feed and in both types can be balanced instantly.

Obviously, the *effect* of load change would be more quickly felt in the case of the Erosion Furnace, but to offset this the changed load could be more quickly stabilized. Also the control provided by the large number of small burners would furnish a much more efficient means to anticipate load changes. It was surprising that fear was expressed that channelling of the glass and products of combustion would occur in the Erosion Furnace. Aside from the fact that trials have actually proven that such is not the case, it should be evident to anyone acquainted with the physical factors involved that this would be so. The inert filter bed or screen consisting of lumps of slowly eroding material do not *cause* but *break up* the tendency to channel. It is the large cavernous volume above the metal line in conventional tanks that causes flame channelling, a detrimental phenomena that is not recognized as much as it should be. The same is true of the glass in the large bath below the metal line.



In both cases, channelling occurs to an extreme degree and there is little that one can do about it for the reason that no adequate local controls are available. In both instances, it is a case of "deuces wild" and both flame and glass pass on their way subject to the whim of uncontrollable forces. It is better recognized in the glass because of the relative ease of current detection. Anyone who, like myself, has had years of operating experience with tanks knows that if channelling were not present, the batch in the doghouse would not appear at the fabricating point until after several days. Actually, some of the glass channels through in a few hours while other portions take days, even months, to complete the trip.

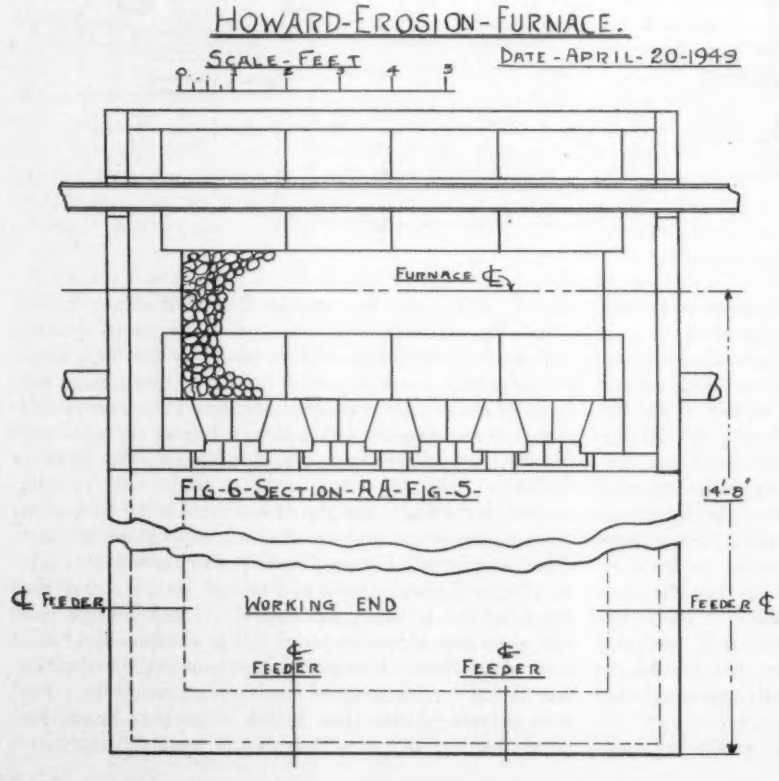
It is desirable to provide some means for controlled channelling in the Erosion Furnace in order to obtain maximum tonnage. Moreover, draft must be provided by exhaust fans at the outlet of the briquette storage bin as the temperature is absorbed by the briquettes to within a few degrees above room temperature. Also a pressure somewhat higher than atmospheric is necessary in the fuel combustion chambers because passage through the interstitial spaces causes more resistance to the passage of flames than a similar area in a flue.

At the best we have to provide an enormous heat receiving surface per ton in order to provide for this flame passage area. This condition is aided by the relatively small amount of radiating surface and the consequent reduction in fuel and air required. Some have expressed the fear that the glass will melt and run down over the filter bed lumps too rapidly to become plained. This fear is quite unnecessary as glass has been plained from briquettes in nine minutes with a travel of from 2 to 3 feet. There seems no valid reason why a square foot of heat receiving surface in the erosion furnace should not heat up, melt and plain as much glass as a square foot of surface in a conventional bath. But in the two furnaces shown in the sketches, I provide approximately 60 square feet of heat absorbing surface per ton of glass as against 6 square feet for the ideal conventional tank used in arriving at the figures for comparative heat balance of the two types shown later.

Pollution and Dilution

It must be emphasized that the outstanding advantage of the Erosion Furnace is the elimination of dilution as a cure for "pollution" or partially plaining glass by continually diluting it with less polluted or more nearly plained glass. In the Erosion Furnace, the glass cycle is progressive, each portion becoming more plain and not returning to mix with other less finished portions to dilute the pollution. That is what happens in any bath method, either pot or tank, and the convection currents eventually dilute the mixture until we call it plained.

Plaining requires large volumes of glass and a long period of time at extremely high temperature to reach whatever degree of plainness is considered necessary. Two designs of Erosion Furnace are shown: First, a round shaft type of 50 tons daily capacity. Second, a rectangular type of 60 tons capacity. The comparative balance is between the 50 ton round shaft type and an ideal standard Siemens bath type, the figures for which are potentially attainable. Any competent furnace engineer can check the figures, and by means of the scale shown on the drawings can estimate fairly closely the dimen-



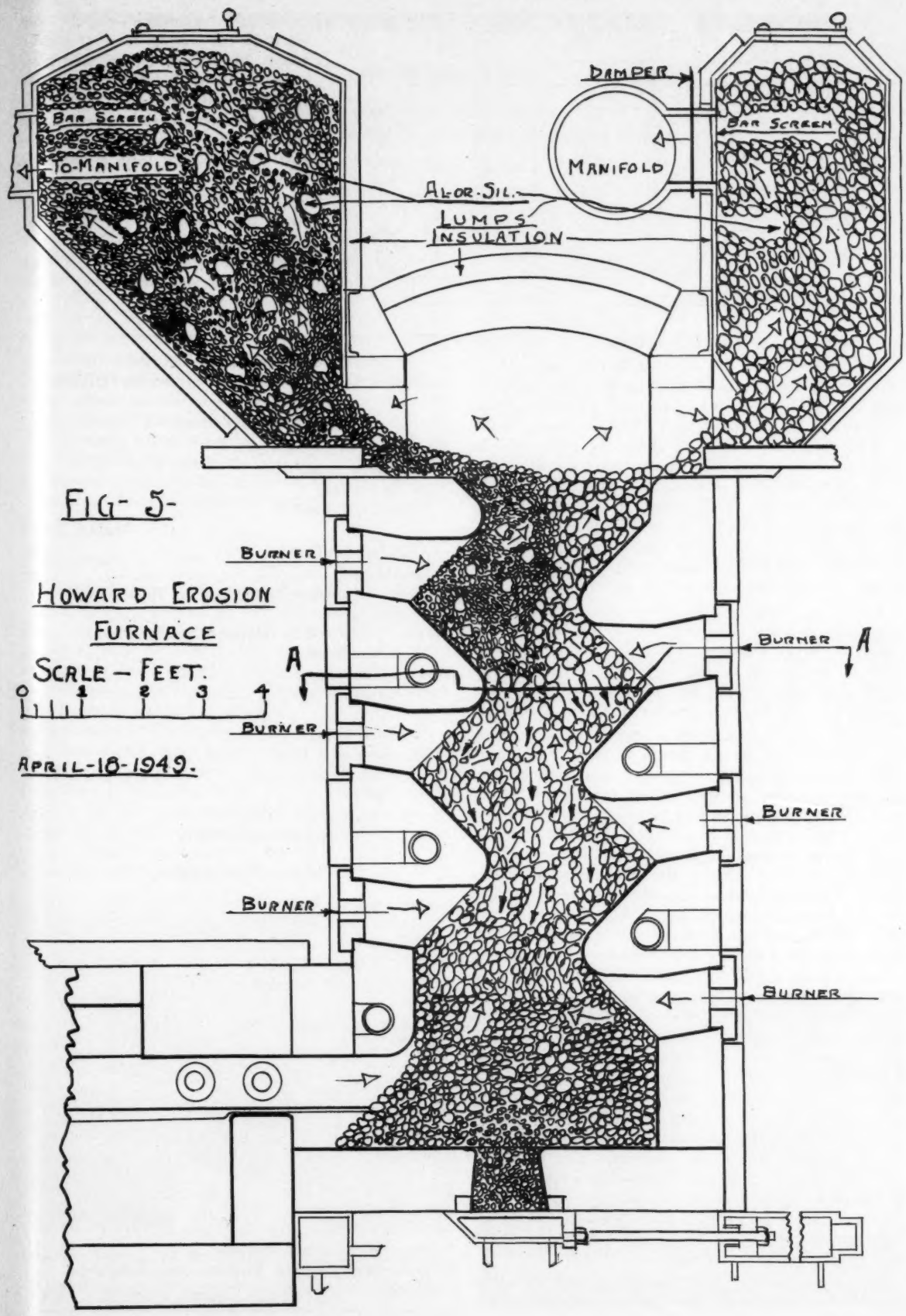


FIG- 5-

HOWARD EROSION FURNACE

SCALE – FEET.

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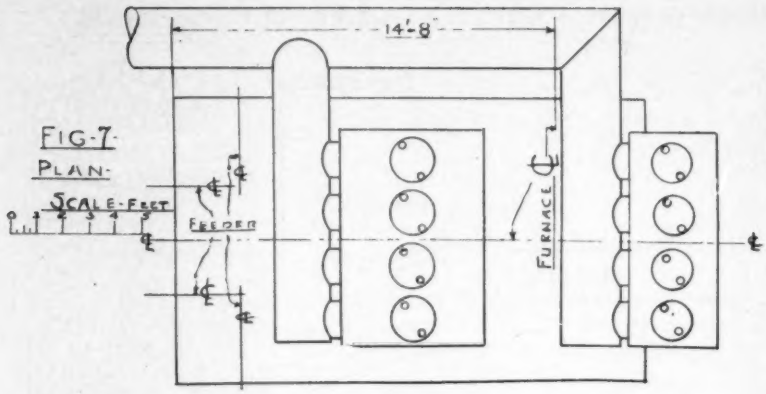


sions and cost of building a furnace of this type.

Figs. 1 to 4 show the round shaft type designed for the use of certain kinds of silica brick which are low in iron and highly resistant to corrosion. These are obtainable as bats at a nominal price. Specific gravity is low and the provision mentioned above for preventing the small pieces or lumps from passing into the working end is thought sufficiently clear as to not require a lengthy detailed description. It is obvious that a wide latitude in engineering is possible to meet such difficulties and problems as may arise when data from an actual trial is secured. It should be emphasized that an entirely different operating technique will be required.

Figs. 5 to 7 show a similar furnace for an estimated 60 tons daily capacity. This is a rectangular type and provides for larger tonnages. Until we have further data from an actual trial at least on pilot scale, it is difficult to estimate some features that may be desirable or even necessary to satisfactorily produce a commercial design.

The furnace, Figs. 5, 6 and 7, shows the use of material of the heavy gravity aluminous kind. Such materials are available, both electrocast and sintered, with ranges in alumina content from 40 per cent to 99 per cent. The subject of the best material for the filter bed lumps while important is complicated and its development too voluminous for the space available in an article of this kind. Suffice to state that my study of this phase of the subject has convinced me and those with whom I have collaborated that while it is probably the most difficult problem involved in developing commercially this type of furnace, it can be satisfactorily solved.

Attention should be called to the fact that the furnace, Figs. 5 to 7 inclusive, provides local controls for the heat application to the glass currents laterally in the working chamber. This is something entirely lacking in the conventional tank and causes channelling. To those interested in the overall economics of this type of glass melting, I would point out that there is in this system a potential advantage in the elimination of the glass temperature as an economic factor. In the conventional tank, the glass temperature is not determined as a glass factor. It is largely economic. Heavy loads require high temperatures in the glass itself and these temperatures are not so much for the glass cycle, but necessary in order to gain a small fuel advantage in the race between heat absorbed and heat radiated.

The large excess of heat absorption surfaces in the Erosion Furnace and the low area of radiation surface permit this furnace to run even more efficiently at lower than at higher loads. The required flame and glass temperature can be much lower. As radiation and stack loss are such a small fraction of the corresponding items in the conventional tank, the fuel cost for idle load is radically lower. Since 15 per cent, on the average, of tank operations is at idle load, this results in a substantial annual saving.

The following table gives a comparative heat and fuel balance of the two types of furnace:

COMPARATIVE HEAT BALANCE OF PROPOSED EROSION AND SIEMENS FURNACE

Erosion Furnace

Capacity 50 tons 25% Cullet
Good Quality Bottle Glass
As per sketches
Figures 1, 2, 3 and 4

	Million B.T.U.
Absorbed by Glass	93.00
Stack Loss	13.35
Adjusted to relative proportion of Input and temperature	
Stingout—adjusted to relative exterior surfaces	4.50
Checker Radiation	None
Working End Input	22.10
Tank Radiation	3.87
Total Input	136.82
Less Recovered Heat	7.60
Fuel Input	129.22
Per Ton	2.59
Saving over Siemens (Ideal)	45%
Savings over Best Average Practice	68%

Siemens Tank Furnace

Capacity 50 tons 25% Cullet
Good Quality Bottle Glass
Best attainable practice
25% better than Average of
Best Commercial Practice

	Million B.T.U.
Absorbed by Glass	93.00
Stack Loss	69.50
Stingout	35.00
Checker Radiation	62.00
Working End Input	None
Tank Radiation	125.00
Total Input	384.50
Less Recovered Heat	149.50
Fuel Input	235.00
Per Ton	4.70
Increase over Erosion Furnace	81½%
Increase Best Average Practice over Erosion Furnace	142½%

BONDED REFRACTORIES FOR SPECIAL PURPOSES

By R. W. KNAUFT

Vice President—Sales
The Chas. Taylor Sons Co., Cincinnati, Ohio

Part II

Furnace Crowns

Standard silica and low alumina, super-duty silica brick have given short life in some high temperature furnaces in which fluoride opal and boro-silicate glass are melted at melter temperatures ranging from 2820 to 2940°F. The vapor and fumes rising from the batch attack the silica refractories in the super-structure quite rapidly. In end port tanks which are used for melting boro-silicate glasses, we have observed greater and more rapid attack of the crown and super-structure of the refiner than of the melting end. In day tanks and continuous tanks where silica brick are not doing the job, bonded kaolin, standard mullite and fortified mullite refractories are giving highly satisfactory and economical results in the super-structure, including the complete furnace crown.

Insulation

Badger, Fugman and Vormelker,[4] and J. W. Romig,[5] have published data on the heat balance of glass tanks and have shown that about 10% of the BTU's supplied to the furnace are lost through the crown by radiation and convection. Badger's data were calculated for a furnace having 1,000 sq. ft. of melter when the furnace was in the 10th month of operation. It is estimated that approximately 44% of that portion of the heat which is lost through the crown can be saved by insulating a 12" bonded mullite brick crown with 2½" of 2200° grade of insulating brick, using the K factor of bonded mullite, with a hot face temperature of 2750°F. 4½" of insulating brick will increase this figure to approximately 64%. Bear in mind that the net saving in BTU's will be on the order of 4 to 5% of the total heat supplied as a maximum of only 10% of the total heat supplied is lost through the furnace crown.

With the price of most fuels at an all-time high, this 4 to 5% saving will help appreciably to defray the higher cost of the bonded mullite crown since the selling price is about 10 times that of silica. We do NOT contend that bonded mullite brick should be used in place of silica brick on furnaces where silica brick are doing an excellent job, lasting for 2 or more campaigns. Based on calculated fuel savings, a crown of standard bonded mullite 12" brick, backed with 4½" of insulation would have to run about 3½ years to show economy, or about 4½ years if only 2½" of insulation was used. Incidentally, plotting cost of high temperature insulation against heat saved for varying thickness of insulation shows that 4½" is about the breaking point. Beyond 4½" the quantity or value of BTU's saved is not enough to return the cost of the greater thickness of insulating material. Fig. 36.

We should like to emphasize the fact that bonded mullite refractories can be insulated safely and without adverse effect on service life, at glass furnace operating temperatures. Back-up insulation does not increase the hot face temperature noticeably, but the mean temperature through the refractory wall is raised appreciably. Fig. 37. That is why it is not practical to apply back-up insulation to glass furnace ports or walls which are built of fire clay, super-duty or some of the diaspore base hi-alumina refractories. Refractories in this class have a longer softening range and an increase in the rate of plastic flow at and just behind the hot or working face will accelerate the rate of erosion by attack from the fluxes in batch carry-over. We suggest that ports and end walls which are built of bonded mullite refractories be insulated with 2½" of suitable material to save fuel and to provide for more comfortable work-

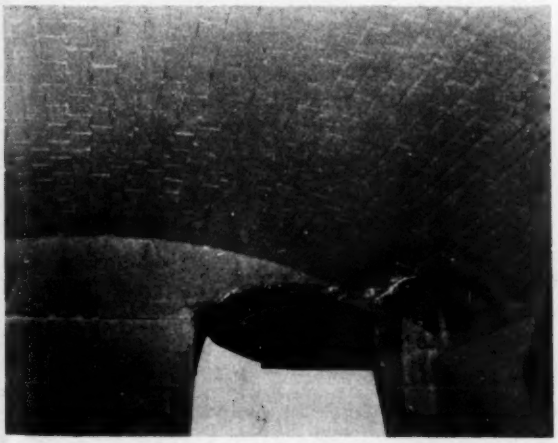


Fig. 34. Twelve inch thick crown of bonded mullite-fortified brick crown of end port furnace, melting special soda-lime glasses, after two fires totaling 458 days. Crown insulated with 2½" of C-22 insulating brick.

Fig. 35. Same as Fig. 34 *after* 832 days, four fires. Average of 11" of mullite brick remaining.

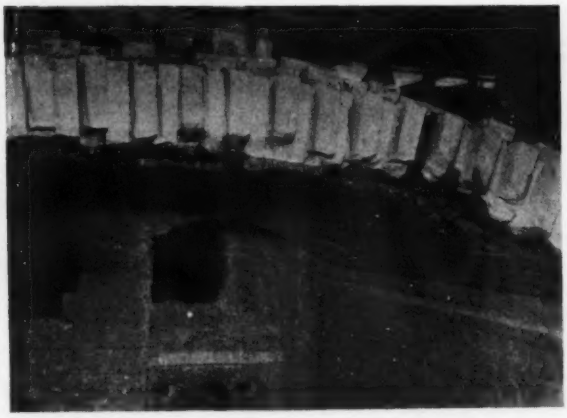


Fig. 36. Fortified bonded mullite brick tied into basic brick port up-take after two fires. Both refractories were insulated with 2½″ of C-22 insulating brick.

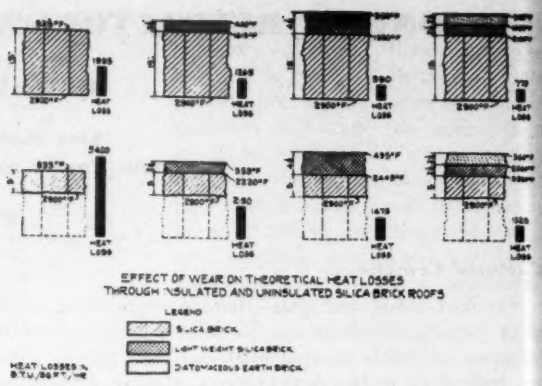

EFFECT OF WEAR ON THEORETICAL HEAT LOSSES
THROUGH INSULATED AND UNINSULATED SILICA BRICK ROOFS
LEGEND
SILICA BRICK
LIGHT WEIGHT SILICA BRICK
DIATOMACEOUS EARTH BRICK

Fig. 37. Effect of wear on theoretical heat losses through insulated and un-insulated silica brick roofs.

ing conditions around the furnace.

Ordinary silica refractories and a general discussion of the insulation of glass furnaces are beyond the scope of this paper, but you may be interested in this Fig. 38 showing the excellent condition of a 13½″ silica crown on a very large flat glass tank after 22 months of continuous service. Crown insulated with 2½″ of C-22 brick, spacing the insulation away from all steel work and the invert relief and port arches in the crown. 64,000 tons melted with average temperature of the melter crown 2720. Inter-face temperature 1750° and cold face temperature 320°F. Operator estimated fuel saving of 6% over entire campaign. Tank fired with relatively soft, luminous flame, with little sting-out present.

Sintered Alumina or Corundum

Bonded refractories containing 85 to 95% Al_2O_3 are produced for special application. Calcined alumina of high purity is formed into marbles or pellets and charged into a fuel fired converter where they are heated nearly to the point of fusion. After sintering, the pellets are crushed, ground and screened to yield a strong, dense aggregate which will average less than 4 to 5% porosity. When bonded with the minimum amount of suitable plastic clay and then fired to temperatures between 2800 to 3000°F, these refractories have excellent resistance to slagging and exceptional hot load strength. Under an applied load of 25# PSI, at 2900°F, one brick of this class deformed only —0.5%. At 2460°F, super-duty fire brick will deform on order of 3.0 to 4.0%. Weight of 9 x 4½ x 2½″ brick is 10.0#.

In service, some tendency of these refractories to shell or peel at the face has been observed when used in furnace super-structure. Their high first cost, around $1.00 per 9″ brick, as compared to 0.50 to 0.60 for standard mullite or 0.65 to 0.70 for mullite—fortified, has discouraged wider application in the glass industry. The product shows excellent promise and further and more interesting developments in bonded refractories within this class can be expected.

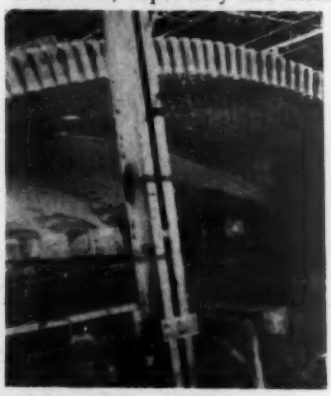


Fig. 38. Insulated 13½″ silica brick crown of flat glass furnace after 22 months of service. Furnace repaired and crown left in place for second campaign.

Zircon

The use of Zircon ($ZrSiO_4$, and Zirconia ZrO_2) special refractories in the glass industry has grown appreciably since 1930. An electrically fused and cast tank block which contains approximately 11.00% SiO_2 and 40.00% ZrO_2 is regularly supplied and has proved to have outstanding resistance to corrosion by soda-lime, dense opal and certain boro-silicate glasses. Bonded Zirconia refractories are available, but their use has been limited by very high first cost and poor resistance to cracking from thermal shock. The low resistance to

Fig. 39. Bonded Zircon brick and shapes used in silica crown of continuous tank melting dense opal glass after 12 months. Zircon used for the vulnerable area between ports for the crown skews and for the skews and starter brick of the silica relieving arch over the port arch. Zircon brick project 4 to 6″. Test Zircon flux blocks appear in excellent condition at lower left in place for second fire.

Fig. 40. Bonded Zircon inserted tube seat in mullite feeder spout. Opal glass. Practically no erosion or loss of original shape.

Fig. 41. Bonded Zircon inserted tube seat in mullite feeder spout. Borosilicate glass. No apparent loss and in excellent condition.

thermal shock is related to large and rapid volume changes which occur as Zirconia passes through an inversion at about 1000°C. Curtis[6] has stated that the suppression or elimination of this inversion has been studied by several investigators, showing that it can be obtained by forming solid solutions of ZrO_2 with CaO, MgO, CeO_2, ThO_2 and BeO. The selling price of such stabilized Zirconia is on the order of $8.00 to $12.00 per standard 9" brick which limits their application in the glass industry on a commercial scale. Undoubtedly progress will be made and means will be found to produce these refractories at a lower cost if a place for them can be found in the industry.

Bonded Zircon (zirconium-silicate) refractories are regularly produced in quantity, without the addition of clay or auxiliary binders. Alumina is present only as a minor impurity in the raw material, as shown in a typical analysis:

	Per cent
SiO_2	34.46
Al_2O_3	0.16
ZrO_2	64.75
Fe_2O_3	0.07
TiO_2	0.25
CaO	0.08
MgO	0.03
Alkalies	0.01
	99.81

The Zircon used in the form of a concentrated and fine grained sand which is recovered as a minor constituent of beach sands which are found in Florida, India and Australia. It is really a by-product of the recovery of ilmenite and rutile and since the titanium bearing minerals are being used in increasing quantities, in alloys, as pigments and as welding rod coatings, we expect that Zircon for refractories and other uses will be available in larger quantities and at lower costs. The coarse grain sizes or grog, which are essential to the making of refractories, are obtained by the partical sintering of the raw and relatively pure zircon sand. Uniformly dense structure and high mechanical strength are obtained by a combination of blended grain sizes, special forming methods and by firing the molded piece to the point where a fritted bond develops by incipient fusion of glass between grain boundries. Zircon refractories are used to prolong the service life of the "balanced" glass furnace and to improve glass quality when used as feeder parts, in connection with the production of fluoride opal, boro-silicate and special glasses. Fig. 39. Not generally recommended for soda-lime tanks, furnaces or feeders Fig. 40-41-42.

Part III

The following photographs illustrate a few of the more common causes of failure of either bonded or

(*Continued on page* 522)

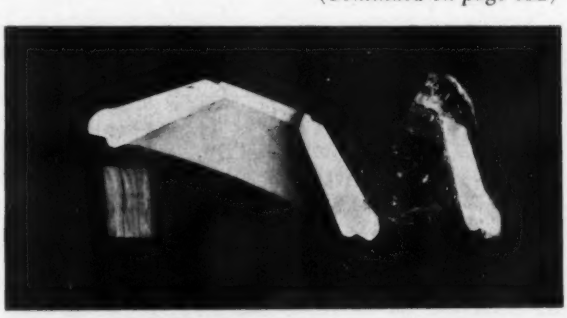


Fig. 42. Bonded Zircon orifice ring after 41 days of service on borosilicate glass. Compare section with that of new ring at left. Removed for job change.

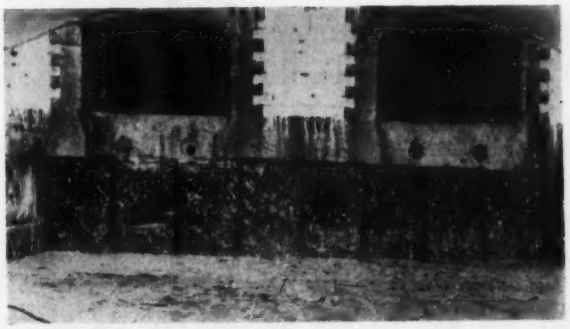


Fig. 43. Wrong method of bonding or tying bonded mullite or any aluminum-silicate refractory into silica end wall, breast walls or jambs.

GLASS CONTAINER SALES RETURNING TO SEASONAL PATTERN

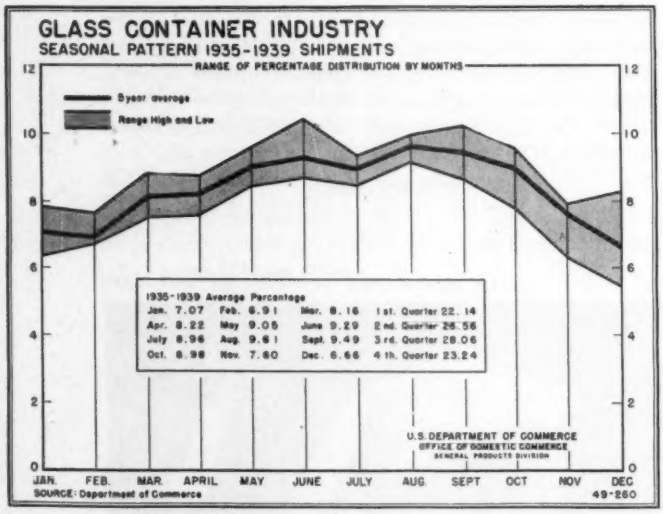
In a recent issue of the Department of Commerce Publication, *Containers and Packaging,* it was reported that the year 1949 should see the national economy return to a state where container seasonal ups and downs could be anticipated with reasonable certainty and that industry could plan accordingly. To further explore this general statement, which was made with respect to all container activities, a detailed individual study of the glass container industry has been made.

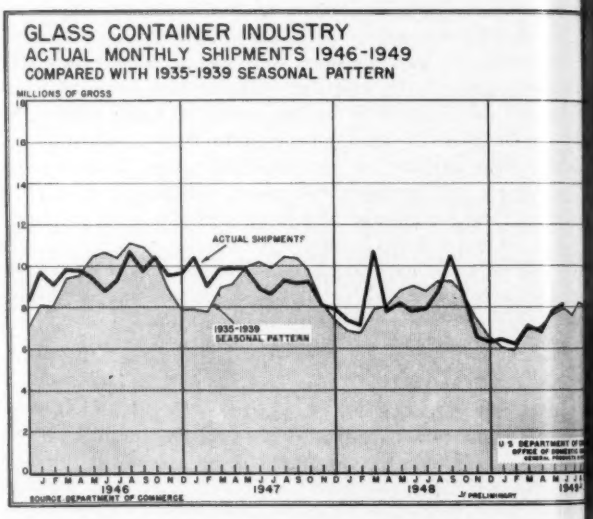
During the latter part of the war and the postwar period, the glass container industry moved completely away from the seasonal pattern which existed during the immediate prewar period 1935-1939. This was due, primarily, to shortages of other container materials and packages and to the fact that current demand during at least part of the period was equal to or in excess of the industry's ability to produce. Now, however, with practically all packaging and container production materials in plentiful supply and with domestic demand being readily met in all areas, the glass container industry appears to have returned to its historical seasonal pattern. At least the figures on production and shipments during the past nine months seem to confirm this opinion.

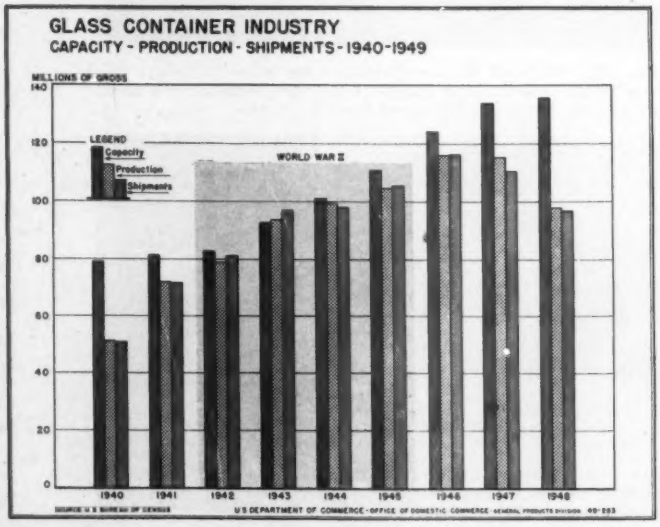
The Department of Commerce has, accordingly assembled a series of charts which give a visual picture of exactly what has happened with respect to glass container shipments. These charts illustrate the statement that the glass container industry, among others, is returning to its prewar seasonal pattern.

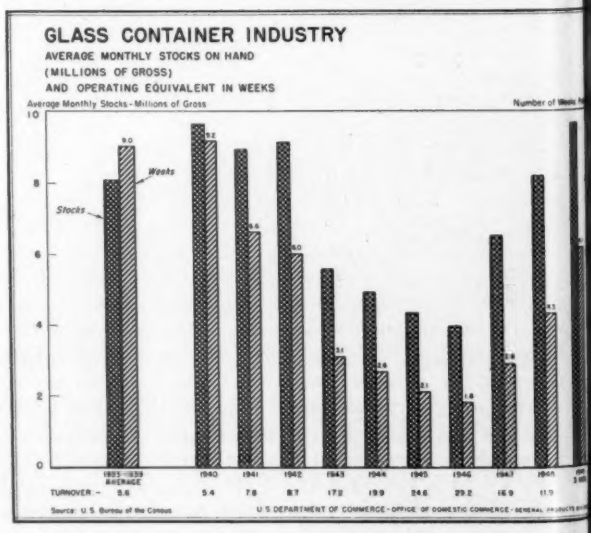
The chart "Glass Container Industry Seasonal Pattern 1935-1939" shows the five-year average seasonal pattern of prewar shipments which was established, as well as the highs and lows during this period. The chart "Glass Container Industry 1940-1948" shows the changes in capacity, production and shipments during the immediate prewar years, the war period and the postwar years. "Actual Monthly Shipments Compared with Seasonal

(*Continued on page* 526)


GLASS CONTAINER INDUSTRY
SEASONAL PATTERN 1935-1939 SHIPMENTS
RANGE OF PERCENTAGE DISTRIBUTION BY MONTHS
5 year average
Range High and Low
1935-1939 Average Percentage
Jan. 7.07 Feb. 6.91 Mar. 8.16 1st. Quarter 22.14
Apr. 8.22 May 9.05 June 9.29 2nd. Quarter 26.56
July 8.96 Aug. 9.61 Sept. 9.49 3rd. Quarter 28.06
Oct. 8.98 Nov. 7.60 Dec. 6.66 4th. Quarter 23.24
U.S. DEPARTMENT OF COMMERCE
OFFICE OF DOMESTIC COMMERCE
GENERAL PRODUCTS DIVISION
JAN. FEB. MAR. APRIL MAY JUNE JULY AUG. SEPT OCT NOV DEC
SOURCE: Department of Commerce
49-260




GLASS CONTAINER INDUSTRY
CAPACITY - PRODUCTION - SHIPMENTS - 1940-1949
MILLIONS OF GROSS
LEGEND
Capacity
Production
Shipments
WORLD WAR II
1940 1941 1942 1943 1944 1945 1946 1947 1948
U.S. DEPARTMENT OF COMMERCE - OFFICE OF DOMESTIC COMMERCE - GENERAL PRODUCTS DIVISION


GLASS CONTAINER INDUSTRY
AVERAGE MONTHLY STOCKS ON HAND
(MILLIONS OF GROSS)
AND OPERATING EQUIVALENT IN WEEKS
Average Monthly Stocks - Millions of Gross
Number of Weeks
Stocks
Weeks
1935-1939 AVERAGE
1940 1941 1942 1943 1944 1945 1946 1947 1948
TURNOVER - 5.6 5.4 7.8 8.7 17.2 19.9 24.6 29.2 16.9
Source: U.S. Bureau of the Census
U.S. DEPARTMENT OF COMMERCE - OFFICE OF DOMESTIC COMMERCE - GENERAL

LOW COST THROUGH HIGH QUALITY

By WARREN R. PURCELL, Manager of Quality Control
Sylvania Electric Products, Inc., Salem, Massachusetts

Quality Control is concerned with both cost and quality, two of the most vital subjects facing management today. Modern quality control techniques have shown that low cost and high quality are partners, not enemies. This partnership has been fostered by Sylvania through its organizational structure, its use of modern quality control techniques, and its development of classified sampling and inspection cost analysis.

In the parent company, known as Sylvania Electric Products, Inc., there are five divisions: Lamp, Radio Tube, Tungsten and Chemical, Fixture, and Electronics. There are two subsidiaries: The Colonial Radio Corporation and the Wabash Corporation, which manufacture, respectively, radio sets and photo-flash lamps.

Figure 1 shows in part the organizational structure of a company division. It illustrates how the three functions of engineering, manufacturing and quality control are interwoven by means of a line-and-staff organization. Each plant is headed by a plant manager. Where several plants within a division manufacture similar products, the plant managers report to the general manager through a general manufacturing manager. The managers of plants making products of a more individual nature report directly to the general manager.

The direct responsibility for quality is in the main trunk, indicated by the heavy line. Thus the plant manager is directly responsible for the quality of products manufactured in his plant. He in turn holds the manufacturing superintendent responsible for the control of quality during manufacture. The quality control services are indicated by the light lines. For instance, the plant manager depends on the supervisor of quality control for an appraisal of the control of quality during manufacture and for assurance of the quality of the finished products. For trouble-shooting and finding the causes of excessive variability he depends on the supervisor of product engineering.

The functional lines are the dotted lines. Most of the cooperative effort is carried out through these lines. Thus if the supervisor of quality control receives from his inspectors a report indicating bad conditions—excessive variability or substandard quality—he ordinarily reports this directly to the manufacturing superintendent. If the manufacturing superintendent needs assistance in finding the causes of the trouble, he ordinarily calls on the supervisor of product engineering directly.

The Manager of Quality Control

The manager of quality control is on the staff of the general manager of the division. He reports functionally to company management. The various supervisors of quality control report functionally to him. One of his important duties is to ascertain that the methods and procedures used by the supervisors of quality control are

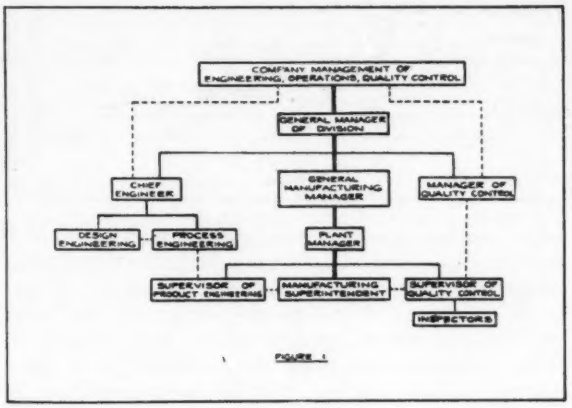


FIGURE 1

adequate and economical, and that the objective being sought at all times is the best balance between the cost and the value of quality. He reviews specifications, inspection procedures, sampling plans and control charts, making studies and recommendations where necessary.

The manager of quality control is not burdened with regular daily responsibilities. He has time to circulate among the heads of purchasing, industrial engineering, personnel, accounting and other functions which affect and are affected by quality control. He is able even to spend time in the field with salesmen in order to get at first hand the reactions of the company's customers to the quality of its products, and thus properly to guide the over-all quality policies of the division. He works closely with the engineering, manufacturing and inspection departments. He studies quality control problems and is able to experiment and check for the best answers. Thus he is in a position to introduce new techniques and procedures in the places and at the times when the greatest benefits are likely to be realized from them.

The manager of quality control should be a practical man but his thinking should not be grooved in the ruts of time-honored shop practices. He should be a man who has the theoretical concepts of statistical quality control and the ability to reduce them to the practical level and apply them. He should have a sales viewpoint in order that his direct contacts with customers will increase rather than decrease his company's good will. He should have the temperament to exert mild pressure constantly and thus to assure that quality control will remain a continuous cooperative effort of the engineering, manufacturing and inspection groups.

Organizational Place of Quality Control

Note in Figure 1 that while the supervisor of quality control usually works with the manufacturing superintendent across the dotted line, he also has access, through the main trunk, to a direct line of authority which can be used when and if necessary. Note also that while the

An address presented at the Spring Production Conference of the American Management Association.

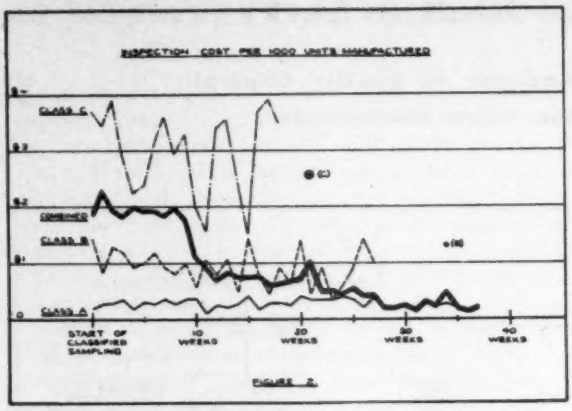


FIGURE 2.

manufacturing superintendent usually works with the supervisor of product engineering across the dotted line, he, too, has a direct line to the plant manager and back to the supervisor of product engineering. In the same way the manager of quality control has available a direct line to the main trunk which enables him to have controls exerted by orders from the general manager, if necessary.

With this organizational structure, quality control administrators have access to direct line authority, but they do not have to use that authority if their handling of problems through the dotted lines is strong and tactful. This has been the policy at Sylvania. Ideas have been sold patiently as ideas rather than issued in the form of orders. In this way improved techniques and procedures have been introduced by evolution rather than by revolution, thus assuring quality control cooperative as well as continuous effort.

Classified Sampling and Inspection Cost Analysis

In acceptance sampling, a number of units are drawn from a comparatively large lot and inspected. If the number of defectives in the sample is small enough, the lot is accepted. If the number of defectives in the sample is too large, the lot is rejected. Usually, rejected lots are inspected 100 per cent and then accepted after the defectives have been removed. The saving realized by acceptance sampling depends on how many lots are accepted on the sample taken. If the number of lots accepted is high, the saving can be substantial. If it is low, the saving can be offset by the costs of administering the plan and the keeping of the more detailed records required.

The number of lots accepted on the sample depends, in turn, on two factors: 1) the pre-inspection, or manufacturing, quality level; 2) the post-inspection quality objective. The better the pre-inspection quality level and the more liberal the post-inspection quality objective, the greater the saving that will be realized by the introduction of acceptance sampling. If the post-inspection quality objective is fixed by competitive standards in the industry and the pre-inspection quality level is materially poorer, inspection costs cannot be reduced directly by acceptance sampling. In this case the only possible attack on the problem is through improved quality control in manufacturing. Control charts and other statistical methods are valuable tools in attaining and maintaining this improved quality control.

Those who are interested in quality control as a profession are well aware of the quality improvements and inspection cost economies which are likely to be realized by the introduction of statistical techniques. Unfortunately, quality control men are surrounded by a vicious circle through which they find it difficult to break. They find themselves in the position of a man who can't get a job without experience and can't get experience without a job; or who can't get business without working capital and can't get working capital without business. They can't show the results of improved quality control without an investment of time and money on the part of management in the installation of the necessary techniques, and they can't get management to make the investment without being able to show results. For management, of course, the circle is just as vicious. A plan to set up new procedures throughout a factory and to conduct courses in their use is hardly in itself sufficient to justify the investment of company funds. There should be some assurance that there will be a return on the investment involved.

Flaws in the Old Inspection System

At Sylvania we were faced with a situation of this kind. On a particular product the competitive conditions required an unusually high quality objective. Generally this level was not being attained in manufacturing. As a result, the standard acceptance sampling plan being used for final inspection was not economical; too many lots had to be inspected 100 per cent. Our problem, then, was first to break the vicious circle. Attempts to improve quality control during manufacture by a superficial application of statistical techniques proved unsuccessful. The difficulty was that we could not measure the things we were trying to control; we could only look at them. We realized that a more thorough application of statistics would probably yield results, but we did not have enough confidence that the results obtained would justify the necessary expenditure. Instead, we made a careful analysis of the final inspection sampling plan.

Our study brought out some interesting facts. It became evident that the manufacturing quality of many product types was consistently quite satisfactory, while that of other types was consistently unsatisfactory. Yet from the satisfactory types an occasional bad sample was drawn. Did these bad samples really indicate bad lots or were the bad samples due to chance in sample selection?

To answer this question we tabulated and analyzed the data from a 100 per cent inspection of the lots which had been rejected on the sample. It became evident that a poor sample drawn from a process with a good history was less likely to indicate a poor lot than would be the case if the process had a poor history. Furthermore, a good sample drawn from a process with a poor history was less likely to indicate a good lot than would be the case if the process had a good history.

How Classified Sampling Works

We experimented with the use of a more liberal sampling plan where the process history of the item was good, and a stricter plan where the process history was poor. By repeated inspection checks we found that this procedure would not have an adverse effect on the post-

inspection quality level of the products. Actually, our findings show that there is greater danger of accepting a poor lot where the process history is poor and the sample is good than there is where the process history is good and the sample is poor.

Next, we classified our product types by their immediate past quality performance. We have three classes: A, B and C. Class A types are those products with a recent quality history definitely better than the post-inspection quality objective. They are inspected under a liberal sampling plan which uses a comparatively small sample and very seldom requires 100 per cent inspection. Class B types are those with a recent history at or near the post-inspection quality objective. They are inspected under a less liberal plan which provides for a medium-sized sample and occasional 100 per cent inspection. Class C types are those with a recent history definitely poorer than the post-inspection quality objective. They are inspected under a strict plan, with a comparatively large sample and frequent 100 per cent inspection. Once a week the history of each product type for the two weeks immediately preceding is summarized, and the type is reclassified.

When the plan was first installed, the amount of inspection on the new basis was about the same as it had been under the old system. But the distribution was markedly different. Because of the classified sampling method used, the inspection cost had become highly sensitive to the pre-inspection quality level. There was a substantial reduction in the amount of inspection on Class A product types and a substantial increase on Class C types. These inspection costs are analyzed weekly and the results, in terms of inspection cost per 1,000 units manufactured, are published in chart form. A typical inspection cost chart for one of our plants is shown in Figure 2.

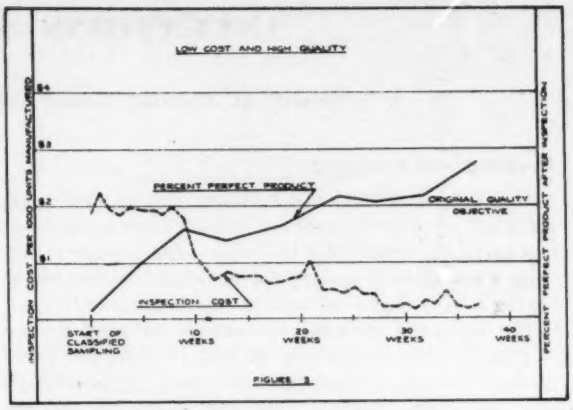


FIGURE 2

Posting Results

The chart starts at the time classified sampling was installed. The cost of inspection per 1,000 units manufactured started at over $3 on types in Class C, at about $1 on types in Class B, and at about 25 cents on types in Class A. Average cost for the three classes was in the neighborhood of $2 per 1,000. Here was "gold in the mine" which could be salvaged by improving the manufacturing quality of the types in Class C.

First there was an incubation period, during which the situation was discussed with the personnel involved and the importance of the $3 cost on Class C types as compared with the 25-cent cost on Class A types was being realized. Following this period there was a specific concentration of control effort on the types in Class C. This control effort was exerted by the foremen and the supervisor of product engineering as part of their regular duties. No special techniques were applied. It took a few weeks for the results of this effort to show. But after a period of eight weeks of incubation and cooperative effort, a rapid reclassification of many types from Class C to Class B began to take place. This period of rapid improvement lasted until the twelfth week, at which time there were very few types remaining in Class C, and the combined average of inspection cost for all classifications had dropped to about 70 cents per 1,000. The few types still in Class C were "stubborn" cases but by the nineteenth week the point was reached where there were no types in Class C. More work remained to be done, however, since the then average cost of 60 or 70 cents was far above the apparently attainable objective of 25 cents per 1,000.

At that time work was started on the improvement of Class B types to Class A. In the twenty-first week two types fell back into Class C and the combined average inspection cost jumped to $1 but this situation was quickly remedied, and from then on no types fell into Class C. The improvement of types from Class B to Class A continued, until the combined average cost dropped to 35 cents in the twenty-seventh week. In the twenty-eighth week we reached our ultimate objective of raising all product types to Class A. Since the twenty-eighth week of our project the combined inspection cost average has been about 20 cents per 1,000 units manufactured, with the exception of the thirty-fourth week, when one type fell back to Class B for a week.

Results of the Experiment

Our experience here and other similar experiences have indicated to us that one of the most important tools in quality control work is the combination of classified sampling and inspection cost analysis. Classified sampling can be designed not only to give the post-inspection quality protection needed, but, what is more important, to make the inspection cost sensitive to the pre-inspection quality level. By means of inspection cost analysis the results of inspection can be reported in the universal language of dollars and cents.

This method has proved effective not only in attaining, but also in maintaining quality control. This is apparent in the speed with which the temporary lapses in the twenty-first and thirty-fourth weeks were remedied. As soon as quality starts to deteriorate on any type, the supervisor of quality control points out to the manufacturing superintendent that the classification may change and the cost of inspection will mount unless speedy action is taken.

Our experience has also indicated to us that company personnel has a large part of the "know-how" required to do the job of raising quality. Their effectiveness is enhanced when the resultant inspection cost reductions are proved to be clearly attainable. It is still true that statistical techniques help in many of the critical spots. Our present policy, however, is first to provide a pro-

(*Continued on page* 520)

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Feeding and Forming

Machine for Making Glass Blocks. Fig. 1. Patent No. 2,478,812. Libbey-Owens-Ford Glass Company acquired this invention from John L. Drake. The invention provides a machine for making hollow glass building blocks having a high degree of vacuum within the interior.

The apparatus includes two similar machines 21 and 22 each forming respectively the half 15 of the block and the half 16 from molten glass delivered by furnaces 23 and 24. Each machine comprises a rotary carriage 25 mounted on a horizontal shaft 26 and carrying a series of mold carriers 27, 28, 29, etc. Each carrier contains a mold having an outer section 30 and an inner section 32. These two sections are movable radially and independently of each other by cylinders 34 and 36.

Plungers 37 and 38 are arranged to cooperate with the inner mold sections 32 and when actuated by cylinders 41 and 42, press the halves of the block. The glass is delivered to the molds from outlets 46 in the bottom of the furnaces under the control of vertically movable plungers 47. Shears 28 sever the discharged glass and allow the charge 49 to drop into the mold. The carriages then rotate toward each other so as to bring the charged molds into cooperative position with the plungers 37 and 38 at which time the pressing operation takes place.

The molds then move to horizontal position when the molds are moved toward each other until the outer mold sections contact thus forming a closed chamber which is connected with a source of vacuum. The inner sections of the molds are then moved toward each other so as to press the two block sections together. As this is done in a vacuum chamber, the air inside the block is at a low pressure. Additional heating means may be employed to keep the adjacent edges of the halves at welding temperature.

The patent shows details of the mechanism for producing the necessary movements at the right time so that the whole operation is automatic. The finished block is delivered upon further rotation of the machine after the weld has set.

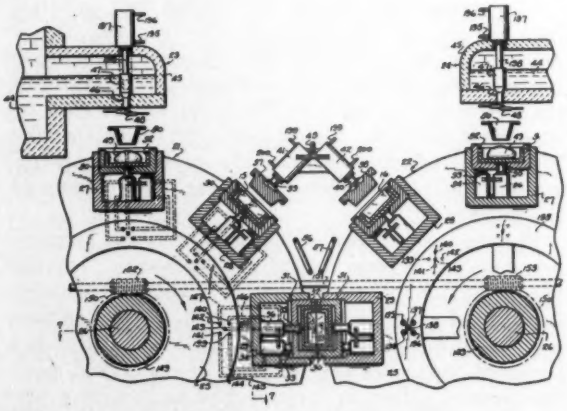


Fig. 1. Machine for Making Glass Blocks.

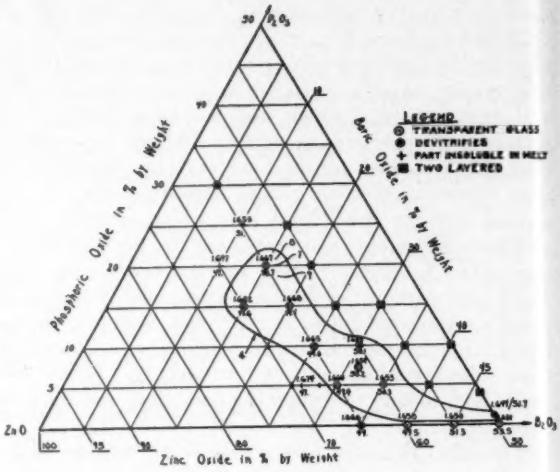


Fig. 2. Optical Glass.

The following references are of record in the file of this patent. United States Patents: 2,006,818, Zimber, July 2, 1935; 2,097,073, Long, Oct. 26, 1937; 2,110,900, Zimmerman et al., Mar. 15, 1938; 2,149,246, Zimmerman et al., Feb. 28, 1939; 2,169,404, Buttner, Aug. 15, 1939; 2,191,953, Blau, Feb. 27, 1940; 2,215,027, Blau, Sept. 17, 1940; 2,235,680, Haven et al., Mar. 18, 1941; 2,238,153, Blau, Apr. 15, 1941; 2,290,088, Bleakley, July 14, 1942; and 2,313,160, Mayers, Mar. 9, 1943.

Glass Compositions

Optical Glass. Fig. 2. Patent No. 2,477,649. Alexis G. Pincus made this invention and assigned it to American Optical Company. The patent gives in detail the valuable optical qualities of this glass.

The figure is a triangular co-ordinate diagram of the major ingredients used showing the relative proportion of each which can be embodied to yield transparent glass.

In the figure dots within the circle as shown at 7 indicate transparent glasses and the numbers 8 above said symbol indicate the index of refraction of said particular composition and the numbers 9 below said symbols indicate the reciprocal relative dispersion. These values are

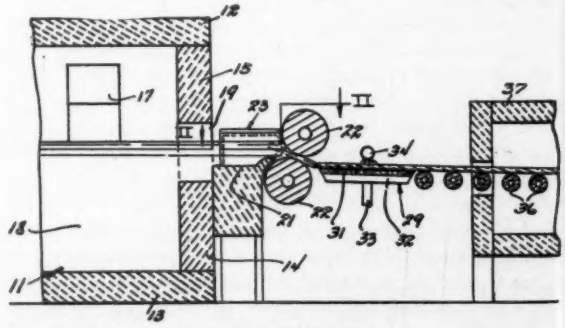


Fig. 3. Method of Making Plate Glass.

given by way of a rough indication of the optical properties obtainable because it is now well known in the art that refractive index is affected by heat treatment and each individual composition when completely compacted by the most favorable annealing schedule would increase to a maximum refractive index. The values given, however, are the approximate indices of refraction and Nu values of said compositions as measured on samples prepared on an experimental scale in the laboratory and approximate the final values.

One composition embodying the invention comprises preferably the following ingredients:

	Parts by weight
ZnO (zinc oxide)	Approximately 50 to 70
B_2O_3 (boric oxide)	Approximately 50 to 15
P_2O_5 (phosphoric oxide)	Approximately 1 to 20

Several other compositions are given in the patent.

The invention may be summarized in Claim 1 which is as follows: A glass composition whose chemical analysis may be expressed substantially as follows:

	Parts by weight
CdO (cadmium oxide)	Approximately 60 to 72
B_2O_3 (boric oxide)	Approximately 18 to 35
P_2O_5 (phosphoric oxide)	Approximately 1 to 10

and with said oxides embodying substantially the entire composition.

The following references are of record in the file of this patent: United States Patents: 2,254,633, Tillyer et al., Sept. 2, 1941; 2,280,322, Tillyer, Apr. 21, 1942; 2,298,746, Moulton, Oct. 13, 1942; and 2,390,191, Stanworth, Dec. 4, 1945. Foreign Patents: 596,471, Germany, 1934.

Sheet & Plate Glass

Method of Making Plate Glass. Fig. 3. Patent No. 2, 478,090. This invention was assigned to Pittsburgh Plate Glass Company by Manson L. Devol of Wilkinsburg, Pa. Difficulty has been encountered in the manufacture of sheet or plate glass when it has been attempted to flow the viscous glass over a refractory surface. This invention overcomes this by making the refractory support of a porous material and forcing a slight flow of air through the material so that the glass is supported on a film of air.

In the figure there is shown a glass tank 11 having the usual top and bottom walls and an end wall 14-15, a slot 19 being formed between these two sections of the end wall. The glass passes through the slot 19, over an apron 21 and then between forming rolls which reduce the sheet to the desired thickness. The sheet then passes over an apron 29 having a porous top 31 below which there is a chamber 32 connected to a supply of compressed air by a pipe 33. At the same time the sheet is cooled by a blast of air from the pipe 34.

The porous top 31 may consist of small particles of refractory material such as graphite or stainless steel sintered together so as to leave minute passageways for the passage of air. This supplies a film of air to support

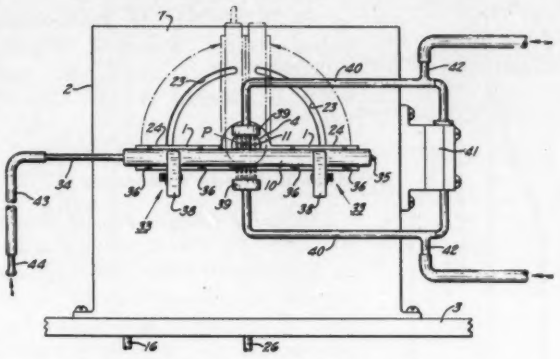


Fig. 4. General Electric Tube Bending Machine.

the glass which is not injured by contact with the refractory. The sheet then passes over rollers 36 to the lehr 37.

The patent gives several examples of the use of this kind of an air film for use in contact with soft glass. It is to be understood that the air passing through the support is not in the form of a blast but rather a slow leakage which keeps the glass from direct contact with the refractory.

The following references are of record in the file of this patent: United States Patents: Re. 16,856, Gelstharp, Jan. 17, 1928; 820,205, Keighley, May 8, 1906; 958,613, Forgo, May 17, 1910; 1,128,448, Hitchcock, Feb. 16, 1915; 1,251,932, Slingluff, Jan. 1, 1918; 1,420,868, Scohy, June 27, 1922; 1,483,336, Corl, Feb. 12, 1924; 1,554,267, Ewing, Sept. 22, 1925; 1,591,179, Myers, July 6, 1926; 1,622,817, Waldron, Mar. 29, 1927; 1,827,138, Brancart, Oct. 13, 1931; 1,841,660, Mambourg, Jan. 19, 1932; 2,162,983, Sullivan, June 20, 1939; 2,243,194, Cook, May 27, 1941; 2,248,717, Nash, July 8, 1941; 2,272,930, Black, Feb. 10, 1942; and 2,395,727, Devol, Feb. 26, 1946. Foreign Patents; 9,033, Great Britain, 1904; and 434,777, France, Dec. 6, 1911. Other References: Powder Metallurgy, Jones, pub. by Edward Arnold & Co., London, 1937, pp. 134 and 135. (Copy in Div. 3.)

Tube & Cane Machines

General Electric Tube Bending Machine. Fig. 4. Patent No. 2,476,658. This patent was assigned to General Electric Company by Alfred Greiner of Cleveland Heights, Ohio. The machine is particularly adapted for making U-shaped bends such as used in certain germicidal lamps. By its use, very sharp bends may be made rapidly and by unskilled workers without collapsing the tube at the point of bend.

The machine comprises a pair of arms 1 pivotally mounted at 4 on a wall 7. A forming pin 11 can be projected into position above the tube 10 which is to be bent. Near the ends of the arms 1 are pins projecting to the rear through slots 23 concentric with the axis of the arms. Mechanism controlled by a foot pedal is provided to swing the arms upwardly to make the bend as shown in dotted lines. The tube is supported by holders 33. Heating burners 39 are positioned at the bending point. In order to prevent collapsing of the tube while being bent, air pressure is applied through a tube 34, the other end of the tube 10 being closed.

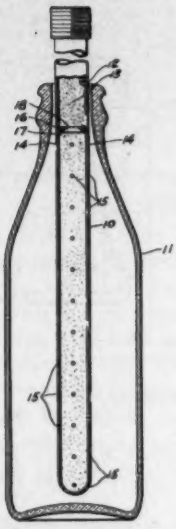


Fig. 5. Tempering Nozzle.

The following references are of record in the file of this patent: United States Patents: 785,082, Brinkman, Mar. 21, 1902; and 2,420,119, Boehm et al., May 6, 1947.

Miscellaneous Processes

Tempering Nozzle. Fig. 5. Patent No. 2,470,245. This is another nozzle for introduction into a bottle for the purpose of suddenly cooling the interior so as to produce a hardened or tempered article. It is the invention of Thomas D. Green of West Hartford, Conn., who assigned it to Hartford-Empire Company. The general object is to apply a coolant to certain parts of the bottle having a greater cooling action than that applied to other parts.

The nozzle shown in the figure comprises a tube 10 adapted to be inserted into the bottle 11 and having a passage 12 at the upper end connected to a supply of cooling fluid indicated at 13. This fluid is compressed air carrying atomized water. The tube or the bottle should be rotated about a vertical axis and the particular form of discharge holes may be as shown. in Green's abandoned application Serial No. 445,910 filed June 5, 1942.

The discharge holes are of two different kinds, the first group indicated at 14 being for the discharge of fluid having a low moisture content and the series 15 which discharge fluid having a greater moisture content. Apparently this difference is produced by "an internal flange, flashing strip or annular fin" 16 which also acts to re-atomize the water carried by the air. In this way the parts of the bottle requiring more rapid cooling are properly treated.

The following references are of record in the file of this patent: United States Patents: 846,211, Johnson, Mar. 5, 1907; 1,026,815, Matteson, May 21, 1912; 1,441,982, Heylman et al., Jan. 9, 1923; 2,180,737, Hess, Nov. 21, 1939; 2,269,060, Mitford, Jan. 6, 1942; 2,275,155, Mongan, Jr., Mar. 3, 1942; 2,302,078, Wadman, Nov. 17, 1942; 2,321,555, Mongan, Jr., June 8, 1943; and 2,347,116, Littleton et al., Apr. 18, 1944.

Television Electrode. Fig. 6. Patent No. 2,473,220. This invention by Albert Rose, East Orange, N. J., was assigned to Radio Corporation of America. It has been proposed to use double-sided mosaic-type targets such as are shown in British Patent No. 442,666 in television pickup tubes but this use has not been by any means satisfactory. Reference is made to Patent No. 2,403,239 for a more complete disclosure of the electrode structure.

Fig. 6. Television Electrode.

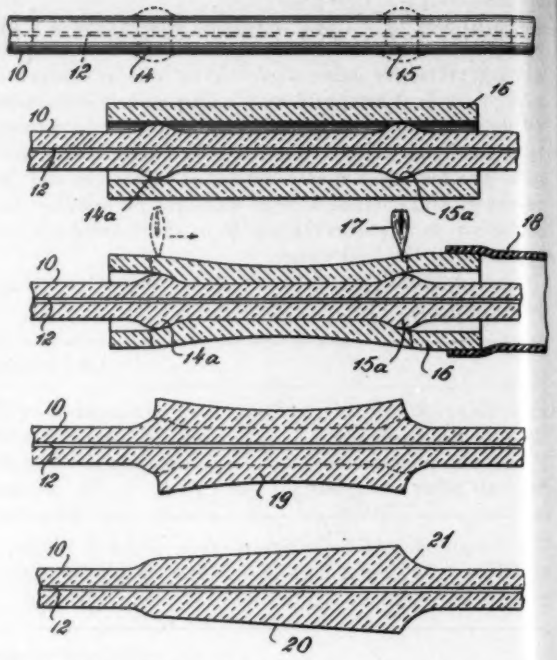


Fig. 7. Tapered Ground Joint.

This invention claims to provide a tube having higher sensitivity and lower distortion than those heretofore in use and also to reduce the cost of manufacture. The target of this invention comprises a very thin imperforate sheet 19 and semi-conducting material and a signal screen 20. The enlarged part of the figure shows a target sheet 19′ and a signal screen 20′ which are more fully set forth in the above mentioned U. S. patent.

The target sheet 19 or 19′ may well be made from a thin sheet of glass having a specific resistance of about 5×10^{10} ohm-centimeters. In the manufacture of this device, a thin glass film is laid upon a metal ring 21 after proper heat treatment. The metal ring 22 supports the signal screen 22. The inventor says he has made such assemblies in which the thickness of the sheet of glass is less than 0.0002" which is less than one-fourth of the thickness of mica usually employed. The patent gives full directions for use of the invention with some modified forms of the invention.

The following references are of record in the file of this patent: United States Patents: 844,767, Arbogast, Feb. 19, 1907; 1,395,963, Kuppers, Nov. 1, 1921; 1,548,611, Kearsley et al., Aug. 4, 1925; 1,562,533, Weintraub, Nov. 24, 1925; 1,876,269, Yagle, Sept. 6, 1932; 2,047,369, Hickok, July 14, 1936; 2,102,049, Warren, Dec. 14, 1937; 2,160,022, Kaufmann, May 30, 1939; 2,179,086, Farnsworth, Nov. 7, 1939; 2,281,280, Gabor, Apr. 28, 1942; and 2,287,546, Binda, June 23, 1942. Foreign Patents: 315,362, Great Britain, Feb. 12, 1931.

Tapered Ground Joint. Fig. 7. Patent No. 2,475,431. This patent relates to the making of tapered ground joints which may be used in many kinds of apparatus but the invention is described as used in the manufacture of thermometers for use in chemical apparatus. The invention was made by Walter O. Luertzing of Vineland, N. J., who assigned it to Lurex Manufacturing Company.

Thermometers for use in chemical operations are often provided with a ground tapered plug to make a tight fit with a tapered socket in some kind of a vessel. The former method of making this joint required great skill and the operation was very difficult because the small bore in the thermometer must not be damaged. This patent discloses a method of making the enlargement to be ground, by telescoping a glass tube over the thermometer at the place where the joint is to be made, melting the tube so that it becomes integral with the thermometer and then grinding in the usual manner.

The figure shows the several steps in making this joint. At the top, a part of a thermometer stem 10 is shown, having a capillary tube 12 as usual. The stem is heated at the points 14 and 15 and the ends of the stem are then forced toward one another so that the soft glass bulges to form collars 14a and 15a. This can be done without distorting the passage 12. A piece of tubing 16 is then slipped over the collars and is heated to the softening point by flames 17. A hose 18 connected to a source of vacuum causes the tube to collapse onto the stem and the ends 16 can then be broken off.

This produces an enlargement 19 which can then be ground to the shape shown at 20 to fit the vessel in which it is to be used. The patent shows a modified form of carrying out the invention. No references were cited by the Patent Office.

Method of Making Silicon Material. Fig. 8. Patent No. 2,475,810. This invention relates to translators of the solid-contact type for use in connection with ultra-high frequencies involving wavelengths of only a few centimeters. Henry C. Theuerer assigned the invention to Bell Telephone Laboratories, Incorporated. By the methods heretofore employed, it has been impossible to cast an ingot of a size much beyond 65 grams but by the use of this invention it is possible to cast ingots weighing as much as 320 grams while still maintaining the required delicate structure of the material.

In Fig. 8 an apparatus for carrying out the method of this invention is shown as comprising a silica tube 1 partly surrounded by high frequency heating coils 2. The bottom of this furnace is filled with aluminum oxide grain 3 which supports a graphite shield 4 enclosing a vitreous silica crucible 5 having very thin walls. A second shield 6 of aluminum oxide surrounds these parts.

The upper end of the furnace tube 1 is sealed into a head 8 surrounded by a water cooled pipe 9 and the interior is connected with a gas supply through a silica tube 11. A stirring rod 15 passes through airtight connections and carries a silica tube 18 at its end. An optical pyrometer 19 is provided to keep track of the temperatures. A hopper 23 feeds the powdered silicon to the crucible 5 with the aid of the stirring rod 15.

It is highly desirable that the character of the atmosphere within the furnace be closely controlled and therefore an exhaust pipe 14 is provided and a connection to a supply of helium for the tube 11.

In the use of this apparatus, the crucible 5 is filled with a measured charge of silicon, the air in and around the crucible is exhausted and helium is supplied in its place and current is turned on to the heating coils 2. The temperature is gradually increased from about 900°C., to about 1600° C., by which time the fusion will be

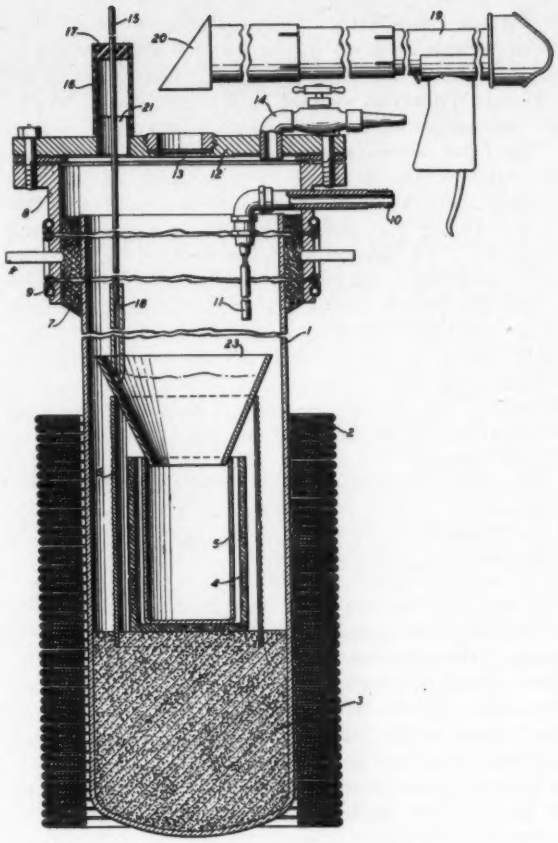


Fig. 8. Method of Making Silicon Material.

complete. The next step is to gradually reduce the temperature during which time the thin walls of the crucible become softened so that its shape can change slightly without rupture in accordance with the internal strain. The melt is solidified by raising the tube 1 at a carefully regulated rate. The patent gives full instructions as to time and temperature. This results in an ingot of crystalline silicon having all the most desirable characteristics for its intended use.

The following references are of record in the file of this patent: United States Patents; 830,738, Potter, Sept. 11, 1906; 1,037,713, Allen, Sept. 3, 1912; 1,572,873, Allcutt, Feb. 16, 1926; 1,738,307, McKeehan, Dec. 3, 1929; 1,769,841, Jones, July 1, 1930; 1,793,672, Bridgman, Feb. 24, 1931; 1,825,011, Navratiel, Sept. 29, 1931; 1,856,851, Neuhauss, May 3, 1932; 2,038,627, Badger, Apr. 28, 1936; 2,079,101, Benner et al., May 4, 1937; and 2,214,976, Stockburger, Sept. 17, 1940. Other References: General Inorganic Chemistry, Sneed; pub. by Ginn & Co., New York, 1926. Page 427. Copy in Div. 5.

Corning Tube Flaring Machine. Fig. 9. Patent No. 2,475,915. Percy L. Orr assigned this invention

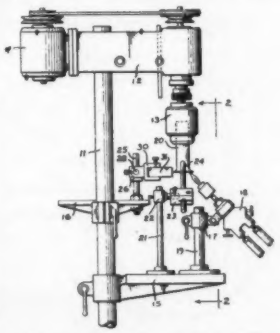


Fig. 9. Corning Tube Flaring. Machine.

to Corning Glass Works. It has always been difficult to make perfect flares on tubing for use in the stems of lamp and radio tubes due to slight imperfections in the tubing in connection with the method employed. This invention enables a more perfect flare at less cost.

The figure shows a drill press assembly comprising the standard 11, the head 12 and chuck 13, and the driving motor 14. The usual auxiliary work supports 15 and 16 are provided. In operation, a glass tube 20 is placed in the chuck 13, a block member 31 is moved close to the end of the tube and a burner 18 is positioned to heat the bottom of the tube. The bottom of the tube when sufficiently softened, expands under centrifugal force limited by contact with the member 31 which is withdrawn so as to permit the desired heating and flare of the tube. This prevents the defects caused by variation in thickness of the tube and any out-of-roundness that may be present.

The following references are of record in the file of this patent: United States Patents: 1,721,983, Bailey, July 23, 1929; 2,001,436, Schultz, May 14, 1935; and 2,266,417, Eisler, Dec. 16, 1941.

Irradiation Chamber. Fig. 10. Patent No. 2,476,152. Sidney O. Levinson and Franz Oppenheimer of Chicago assigned this invention to Michael Reese Research Foundation which is a non-profit corporation of Illinois. This invention provides an irradiating chamber by which the thickness of the film being treated may be maintained uniform throughout the chamber. The chamber is made of two flat plates. For short wave ultraviolet irradiation the side exposed to the irradiation is of very thin high grade optical quartz.

In the figure, a plate 1 of optical quartz having a thickness of less than 0.5 mm., forms the front of the chamber which has a parallel back 2. This back requires less care in the manufacture. These two parts are assembled as shown in the section with a spacer plate 3 of a material capable of withstanding the heat required to fuse the overlapping edges of the two plates together. After fusing the front and back together, the spacer is removed leaving a space between the two parts as small as 0.1 mm.

An inlet tube 4 is sealed to one end of the chamber and an outlet tube 5 to the other end, these being connected by a brace rod 6. The liquid to be treated is admitted through the tube 4, passed through the narrow passage between the plates 1 and 2 where it is subjected to treatment and then out through the tube 5.

No references were cited by the Patent Office during the prosecution of this application.

Reflection Reducing Coating for Glass. Fig. 11. Patent No. 2,474,061. This invention was assigned to American Optical Company by Harold R. Moulton, Southbridge, Mass. The patent is a continuation in part of an abandoned application filed July 24, 1942. Among other objects accomplished by the invention, is the provision of an improved method of making diffusion screens.

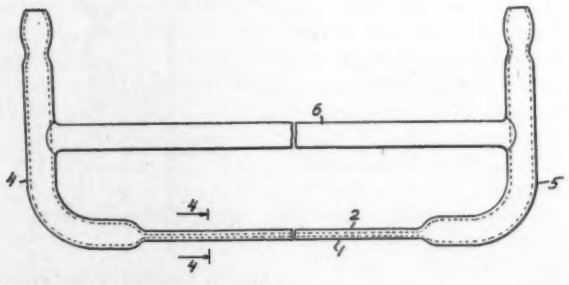


Fig. 10. Irradiation Chamber.

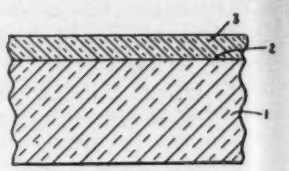


Fig. 11. Reflection Reducing Coating for Glass.

The patent recites some of the prior methods in use and states that this invention provides a quicker way of coating the glass without the use of high vacuum equipment and at a lower cost. The drawing shows a lens 1 having the surface 2 coated with a stable water insoluble coating 3 having a lower index of refraction than the substrate. A recommended solution is five parts tetraethylorthosilicate, 50 parts ethyl acetate, 50 parts denatured alcohol, and five parts concentrated hydrochloric acid mixed in the order given. For some unknown reason, this solution should be aged two to six days or more before use.

In some cases, as with a lens having considerable curvature, the lens should be spun after immersion on the solution in order to remove excess liquid and to regulate the thickness of the coating. Three methods are described for the further treatment of the article, one of these being to place the article in a moist atmosphere at a temperature of about 100°C. for a sufficient time to bring it to a uniform temperature throughout after which it may be cooled. The result is a hard wear resistant reflection reducing surface.

This method may be of value when applied to nontransparent surfaces. Detailed information as to the use of this method are found in the patent.

The following references are of record in the file of this patent: United States Patents: 1,809,755, King et al., June 9, 1931; 2,118,898, Price, May 31, 1938; 2,220,862, Blodgett, Nov. 5, 1940; 2,329,632, Marsden, Sept. 14, 1943; 2,347,733, Christensen, May 2, 1944; 2,356,553, Weissenberg, Aug. 22, 1944; 2,366,516, Geffcken et al., Jan. 2, 1945; 2,371,611, Dimmick, Mar. 20, 1945; 2,384,209, Sukumlyn, Sept. 14, 1945; 2,428,357, Cohen, Oct. 7, 1947; and 2,432,484, Moulton, Dec. 9, 1947. Foreign Patents: 538,273, Great Britain, 1941.

STAUFFER CHEMICAL APPOINTS RESEARCH DIRECTORS

The Stauffer Chemical Company has announced the appointment of Dr. Chester L. Arnold as Director of Research. Dr. Arnold, who until this appointment has been Director of Research of the Western Division, will continue his personal supervision of western research activities and for the present will make his headquarters in Richmond, California.

Named as Director of the Eastern Research Division is John P. Crowther who has been Assistant Director of Research of the company. Mr. Crowther will transfer his offices from New York City to the Process Development Laboratory at Chauncey, New York.

GJ Research Digest

The Solution of the Refractory Blocks in the Tank Wall of a Glass Melting Furnace

It is well known to those who have examined the inside of a tank furnace at the end of its run that the solution of the tank blocks has taken place in a very complex fashion. Grooving and pitting is always observed and often there is considerable difference between the attack on adjacent blocks. These irregularities are due to lack of homogeneity in the blocks, to surface cracks developed during the initial heating up of the tank, and to the flow lines of the molten glass which causes local concentration of glass of higher temperature than the surrounding glass. In spite of these differences, the shape of the side blocks after attack can, in general, be represented by a curve which shows maximum attack at a point near the surface level of the glass and progressively decreasing solution towards the bottom of the tank. The thickness of the blocks at different depths can be represented by a smooth curve.

In this paper by C. E. Gould (*Journal of the Society of Glass Technology*, February 1949), it is shown that the shape of this curve depends upon 1) the surface temperature of the glass; 2) the temperature gradient of the glass; 3) the variability of glass levels; 4) the relation between rate of solution and temperature for the block in question. It is also shown that by making certain simplifying assumptions that the shape of the blocks after attack can be calculated beforehand given a knowledge of the above factors. The assumptions are that the blocks are homogenous in structure and that the surface temperature and the temperature gradient through the glass are uniform over the entire tank area.

Any given refractory dissolves in a given glass at a rate which varies with the temperature. The curve relating solution rate with temperature can be determined by laboratory experiments and if it is combined with one relating depth of glass and temperature, a curve giving the rate of solution against depth results. If the level in the tank remained absolutely constant, this latter curve would represent the actual shape of the block after attack. In practice, the glass level cannot be held constant so the curve relating rate of solution and depth moves up and down. The resulting curve is the sum of all the instantaneous curves and, since the point of maximum attack fluctuates about the mean level, we get a rounded contour at the flux line instead of the sharp level cut which would result from constant level attack. Since the life of the block is determined by the rate of solution at the point of maximum attack, it is apparent that the greater the variation of level, the longer will be the life of the block because the period of attack at any one level is reduced. It is reasonable to assume that the variation of level follows the "normal" law of chance distribution and all that is needed to know is the standard deviation in order to calculate the length of time the glass stands at any given level. The author worked with level variations of ± 2 inches in steps of 0.2 inch and standard deviation of 0.25, 0.5 and 0.75 inch.

The next step was to set up a table of the relative solution at each of these steps in level using the curve relating the rate of solution and the depth, and multiplying the value in each case by the fraction of the total time at each step. The sum of the columns at each level then gives the rate of solution at that level which is proportional to the thickness of block dissolved in constant time. If the blocks are 12 inches thick when new, and it is assumed that their useful life is over when the thickness at the point of maximum attack is reduced to 2 inches, we have only to multiply by such a factor as will make the maximum 10 inches to obtain figures of the final contour of the block.

This method of approach assumes that there is no attack on the block above the glass level at any instant. This is not strictly true since there is always some attack by volatile constituents of the batch and by frit dust held in the gas stream. Also, in actual practice, the long thin piece of block above the mean-level line usually breaks away under its own weight. Another point that should be noted is that the above discussion refers to the solution of refractory in molten glass. The rate of attack may be greater for those portions of the tank where the blocks come into contact with unmelted frit.

Modern mechanized methods of fabrication usually require the glass level in a tank to be kept constant within very narrow limits. This, unfortunately, has an advance effect on the life of the blocks. Calculations show that the relative time required to make the thinnest part of the block 2 inches is the shortest when there is no deviation of metal level and the longest when the metal level varies. The following is an example of such a calculation:

Standard Deviation of Level (Inches)	*Relative Time*
0	1.00
± 0.25	1.46
± 0.50	1.75
± 0.75	1.95

The requirements of machine operation usually preclude the attainment of long block life by deliberately allowing large variations of glass level, but it is sometimes possible to adjust the level of the machines and the glass together in a series of steps during the life of the tank and, at the same time, keep the glass level as constant as possible for the duration of each step. The result of such a scheme was described. Here the glass level was dropped by ½ inch in four steps of equal duration and maintained with a standard deviation of ± 0.25 inch during each step. Using this scheme, the time required to reach a minimum thickness of 2 inches

(*Continued on page* 524)

GBBA REVIEWS ITS CAMPAIGN FOR THE GLASS CONTAINER

In a booklet outlining its efforts to promote the use of glass, the Glass Bottle Blowers Association, with Lee W. Minton as its President, has again shown its desire to work with glass container manufacturers in furthering the use of glass and in educating the general public to the advantages of glass.

The booklet opens with a discussion of Prohibition and its evils, from the ills created through the inevitable use of poison liquor to the aspect of the loss of revenue to the government with the discontinuance of liquor taxation. To combat any current move to bring back Prohibition, GBBA urges all members to, above all, vote and speak strongly against any such move.

Also given mention in this interesting brochure is the opportunity for expansion in the glass container industry through the promotion of the One-Way beer bottle and the steps which have been taken by the GBBA to gain support for its successful acceptance. The paper milk container, the tin beer can and the plastic container are discussed and the advantages of glass over each of these containers are enumerated. The booklet goes on to consider the Taft-Hartley Act and then presents production facts and figures for the glass container industry, cost of living comparisons and the tariff problem.

Throughout the booklet are found reproductions of advertisements which have been run by the Glass Bottle Blowers Association and the final chapter is devoted to GBBA advertising. Advertisements have been run fighting Prohibition and promoting the glass milk bottle, One-Way beer bottles, beverage bottles and glass containers in general.

The activity of the GBBA in helping to make the public glass-minded has made its mark and it is the Association's intention to continue to help promote this idea to the benefit of employee, employer and the glass container manufacturing industry.

GLASS DIVISION MEETING OF A.C.S.

The Glass Division of the American Ceramic Society will hold its fall meeting on October 6 and 7 at Shawnee Inn, Shawnee-on-Delaware, Pa.

Tentative papers scheduled for the meeting include "Surface Tension of Molten Zinc Borates" by Leo Shartsis and Rodrigo Canga of the National Bureau of Standards; "Some Studies on the Solarization of Glass" by J. F. White and W. B. Silverman, Owens-Illinois Glass Company; "Annealing of 517:645 Borosilicate Optical Glass" by Neil M. Brandt, Bausch & Lomb Optical Company; "Influence of Heavy Metal Ions on the Viscosity of Silicate Glasses" by W. A. Weyl and T. A. Kupinski, Pennsylvania State College; and "Effect of K_2O and Li_2O on Properties of Soda-Dolomitic Lime-Silica Glasses", Owens-Illinois General Research and New Development Division.

SODA ASH PLANT TO BE ERECTED IN SOUTH AFRICA

South Africa is planning the construction of a soda ash plant near Douglas, in the northern part of Cape Province, which is expected to cost £5,500,000, according to a report in Foreign Trade of the Canadian Government from Cape Town. Actual construction is expected to begin in the near future, though it is not anticipated that the plant will come into production for three or four years.

At that time, South Africa will no longer be dependent on the importation of soda ash and should be in a position to export a surplus, the report adds.

CANADIAN GLASS MAN DIES

James E. Harrison, a notable figure in the Canadian glass industry, passed away at the age of 71 after serving over 34 years with Pilkington Brothers in Canada.

Mr. Harrison started as Pilkington Brothers' Vancouver representative and a few years later took complete charge of their operation in Canada. He retired from the service of the company in 1945. He was one of the pioneers in the use of extruded and rolled metal sections for the modern store front.

1949 CONVENTION OF THE CZECHOSLOVAK CERAMIC SOCIETY

The convention of the Czechoslovak Ceramic and Glass Society took place on May 19 to 23 in the city of Teplice. The Society reported a significant increase of membership from 614 (January 1948) to 833. The convention stressed international relations, particularly work in the international committees and the extended visit of Dr. W. E. S. Turner.

Among the foreign guests were Dr. Ram Charan, of the Hindu University at Benares. Mr. A. Kral spoke on behalf of American students of ceramics. Mr. J. Kocik, who has worked on optical glass at the National Bureau of Standards in Washington, reported on his experiences in the U. S. A. Other guests came from various Eastern European countries. The technical papers on glass stressed glass-metal seals (M. Cap), durability (F. Laibl) and dielectric properties (J. Voldan).

CURRENT STATISTICAL POSITION OF GLASS

Due to the fact that the Bureau of Labor Statistics has discontinued its current series of statistics on which THE GLASS INDUSTRY's Index of production, employment and payrolls has been based, these figures, with the exception of those pertaining to employment for the current month, and the usual graph must necessarily be omitted from the Current Statistical Position of Glass in this issue. Employment in the glass industry during June 1949 totalled 108,200, a slight increase over May employment of 107,600.

It is hoped that the new series of figures covering the various phases of activity in the glass industry will be available to enable THE GLASS INDUSTRY to resume its monthly Index with the October issue on a somewhat revised basis.

These new statistics will cover the period from January 1947 to date and will include total employment figures for all employees and employment of production workers only. Total payroll figures for production workers will also be resumed. Employment figures will cover glass and glass products: flat glass, pressed and blown ware and glass products made of purchased glass. Payroll figures will include glass and glass products, glass containers and pressed and blown ware.

GLASS CONTAINER SHIPMENTS
(All figures in Gross)

	July 1949
Narrow Neck Containers	
Foods	748,423
Medicinal & Health Supplies	804,927
Chemicals, Household & Industrial	472,569
Beverages, Returnable	902,312
Beverages, Non-returnable	8,831
Beer, Returnable	155,256
Beer, Non-returnable	383,142
Liquors	672,220
Wines	202,186
Toiletries & Cosmetics	422,243
Sub-total (Narrow)	4,772,109
Wide Mouth Containers	
Foods	1,915,640
Dairy Products	252,725
Home Canning	310,649
Medicinal & Health Supplies	183,798
Chemicals, Household & Industrial	88,783
Toiletries & Cosmetics	115,268
Packers' Tumblers	106,655
Sub-total (Wide)	2,973,518
Total Domestic	7,745,627
Export Shipments	172,599
Total Shipments	7,918,226

GLASS CONTAINER PRODUCTION AND INVENTORY
(All figures in Gross)

		Production July 1949	Stocks July 1949
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	2,744,077	3,508,896
	Wide Mouth	2,384,542	2,556,515
Dairy Products		248,151	252,109
Home Canning		170,255	536,551
Beverages, Returnable		996,842	695,037
Beverages, Non-returnable		9,131	9,461
Beer, Returnable		156,176	638,287
Beer, Non-returnable		421,267	354,941
Liquors		676,364	471,415
Wines		218,524	288,430
Packers' Tumblers		82,879	113,108
Total		8,108,218	9,424,750

Glass container production for July 1949, based on figures released by the Bureau of Census, was 8,108,218 gross. This is only slightly higher than the 8,060,774 gross produced during the previous month. During July 1948 production had been reported to be 7,784,960 gross, which is 4 per cent less than for July this year. Glass container production at the close of the January-July 1949 period has reached 51,921,396 gross, as compared with 57,975,915 gross—a difference of 10 per cent.

Shipments for the month of July 1949 were 7,918,226 gross, which is 3 per cent below the June shipment figure of 8,165,907 gross. During July 1948, shipments were 7,803,461 gross, or close to 1½ per cent below July this year. Total shipments thus far in 1949 have reached 50,718,542 gross. This is about 10 per cent below the 56,642,158 gross shipped during the corresponding period in 1948.

Stocks on hand at the close of July 1949 rose slightly from the previous month's 9,268,999 gross to reach 9,424,750 gross Stocks on hand at the close of July 1948 were 8,708,038 gross.

After publication of the figures for automatic tumbler production and manufacturers sales of table, kitchen and household glassware for the month of June 1949, it was discovered that various totals given were erroneous. Therefore, THE GLASS INDUSTRY regrets that it must suspend these figures for this month. Corrected totals for June and the July figures will be published in the October issue.

GLASS FIBERS NAMES PLANT MANAGER

Richard Baker has been appointed Plant Manager of Glass Fibers, Inc., according to an announcement made by R. H. Barnard, President.

Mr. Baker has been with the company since its inception and until recently was in charge of production control. During World War II, he was a Captain and flight commander of a B-25 bomber group attached to the Fifth Air force.

• Pittsburgh Plate Glass Company has purchased a 100,000-square-foot tract of land in the Trinity Industrial District as a site for modern offices and warehouses to serve North Central Texas and Dallas.

PREMIUM PERFORMANCE
Without Premium Price

CRYSTALITE (mullite-bonded mullite) feeder parts now at a new lower price, offer a new 3-way cut into rising glass production costs.

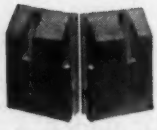
- New lower price
- Same high crystaline bond for longer life
- Same close tolerance dimension accuracy

Specify **REMMEY CRYSTALITE,** the premium performance mullite . . . reduce costs 3 ways!

BONUS-BUILDING SPOUTS
Long-lived, firm closure at tube seat . . . close-tolerance machined for uniformly accurate location in feeder.

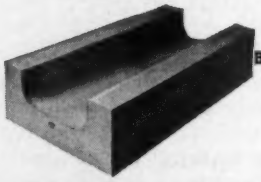
BONUS-BUILDING TUBES
High refractoriness and erosion resistance assure enduring firm closure at tube seat . . . and thorough agitation.

BONUS-BUILDING PLUNGERS
Retain shape longer for continued, more accurate control of glass gob.



BONUS-BUILDING ORIFICE RINGS—Retain shape and size for longer runs without costly replacement shutdowns.

BONUS-BUILDING BURNER BLOCK—Accuracy of dimension for quick, hairline matching to burners.



BONUS-BUILDING CHANNELS
Uniformity, accuracy, and structural quality combine for longer productive life.

REMMEY
Dependable Refractories
RICHARD C. REMMEY SON CO.
Philadelphia 37 • Pennsylvania

BOOK REVIEWS

The Development of the American Glass Industry
By Pearce Davis

Tracing the development of glassmaking in America from its early introduction as a craft by English colonists to its evolution in the twentieth century as a large-scale, mass-production enterprise, this book presents the first comprehensive economic history of glass manufacture in the United States.

It covers technical and mechanical progress, the effects of tariff policy, the adjustments to an expanding national economy and the rise of organized labor in the four major branches of glass manufacture: window glass, plate glass, glass container and the pressed and blown glass industries.

Also discussed in the book are the forms of early union organization, the nature and consequences of union policies and the impact of mechanical revolution on the status of the unionized worker furnishes a hitherto largely inaccessible chapter in American labor history. The effect of tariff protection is analyzed in detail with special attention to the relation of protection to the development of the techniques of production in this country and in Europe. The statistical anaylsis of production and foreign importations sets forth clearly the competitive position of the domestic industry throughout the period.
Published by Harvard University Press, Cambridge, Mass., 316 pages, $6.00.

Building for Daylight
By Richard Sheppard and Hilton Wright

This book is a compact and fully illustrated survey of the methods of planning and siting buildings in relation to the admission of daylight to their interior spaces. It includes detailed specifications for the types of glass for various kinds of buildings—houses, schools, hospitals, hotels and such large scale structures as railway stations.

The book opens with an introductory historical note by John Gloag on the evolution of English window design. Building for Daylight handles each type of building separately from a building development standpoint and then goes on to discuss daylighting in houses, schools, factories, offices, etc. The final section of the book is devoted to specifications for glass in the different types of buildings. Line drawings of the buildings are included and discussed in the text.
Published by The MacMillan Company, New York City, 91 pages, $5.50.

• Glass is among the ten groups showing the greatest rate of growth in demand for chemical products and will be represented at the Chemical Exposition scheduled to be held November 28 to December 3, 1949 at Grand Central Palace in New York City.

• Directors of Sylvania Electric Products Inc., at a recent meeting, declared a dividend of 35 cents per share on the Company's common stock, and a regular quarterly dividend of $1.00 per share on the $4.00 cumulative preferred stock, both dividends payable October 1, 1949 to stockholders of record at the close of business September 20, 1949.

Specify THREE ELEPHANT BORAX AND BORIC ACID

Plant of American Potash & Chemical Corporation, Trona, California

The use of borax in commercial soda-lime-silica glasses has become standard practice during the past few years.

It facilitates the melting process to an extent which is apparent in lower production costs. In a properly balanced batch, borax will improve the strength, color, brilliancy, thermal properties and durability of your product.

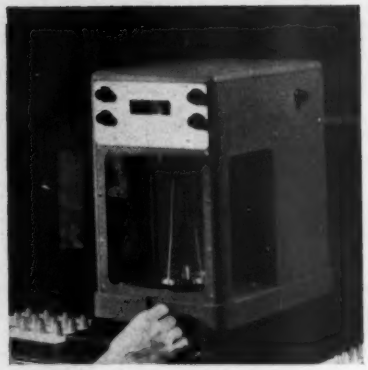
AMERICAN POTASH & CHEMICAL CORPORATION

EAST 42nd STREET • • • NEW YORK 17, N. Y.

S. LA SALLE STREET **214 WALTON BUILDING** **3030 WEST SIXTH STREET**
CAGO 4, ILLINOIS **ATLANTA 3, GEORGIA** **LOS ANGELES 54, CALIF.**

Agents for Three Elephant Borax and Boric Acid: Borax & Chemicals, Ltd., 229 High Holborn, London, W

NEW EQUIPMENT AND SUPPLIES



DIRECT-READING GRAM-ATIC BALANCE

Fisher Scientific Company, Pittsburgh, Pa., has announced the development of a new direct-reading instrument called the "gram-atic Balance" for weighing silica, lead, soda, potash, calcium and other samples to 1/20 of a milligram with analytical balance accuracy.

The new balance has only one pan, and the weight reads directly on a scale at eye level, eliminating a usual source of error in adding up individual weights. The balance has all required weights built-in and manipulated by turning four external knobs. No weights are handled — weights less than 0.1 gram are indicated optically and automatically. Total weight is read directly from a scale on the instrument panel. The sample to be weighed can range from 200 grams (approx. 7 ozs.) to 0.0001 gram.

The knife edges and planes of the balance are sapphire, the pan is gold plated and the case is aluminum with baked lacquer finish. Learning to operate the balance is simple and the company reports that tests have shown that inexperienced operators can learn to weigh samples in twenty to twenty-five seconds after less than an hour's practice. The beam of the balance has a constant load. Therefore, sensitivity remains constant regardless of sample size.

Because of its speed and simplicity of operation, the new balance is extremely suitable for production control at test stations in glass plants. The sturdy construction and elimination of the adding-up of individual weights greatly reduces training time for operators.

IMPROVED GLASS PIPE COUPLING

The Fischer & Porter Company, Hatboro, Pa., has announced a new threaded metal coupling for use with Pyrex glass pipe lines. The new coupling simplifies the installation of glass piping by replacing three-bolt triangular metal flanges. The use of wrenches is no longer necessary and perfect alignment is assured, according to the company's report.

The danger of breakage due to uneven take-up is eliminated, it is further stated. Installation time is reduced up to 60% in comparison with alternate methods. Metal couplings are available from stock in sizes ¼", ½", ¾" and 1" for making glass to glass or glass to metal connections.

NEW DIPPING REFRACTOMETER DEVELOPED

Bausch & Lomb Optical Co., Rochester 2, N. Y., has developed an improved dipping refractometer, a feature of the instrument being its prism mount which provides greater interchangeability of dipping prisms and prevents seepage of liquids and vapors into the instrument's compensator parts. Additional prisms may be purchased and installed without returning the refractometer to the factory for special fitting and alignment.

The sleeve on the mount is about two and one-half inches long and fits snugly over the end of the telescope tube. It is pointed out that the instrument's metal beaker is attached by a threaded locking ring to assure positive contact with the prism mount, thereby eliminating leakage and evaporation of the sample.

A smaller aperture in the end of the beaker permits the light to enter the sample and prism correctly, cutting stray light to a minimum.

AMERICAN OPTICAL MICROSCOPES

American Optical Company, Southbridge, Mass., has announced a completely new series of microscopes incorporating many thoroughly tested new features and refinements for the convenience of industrial laboratory and research workers and others who need a precision microscope.

Pilot models of the new AO Spencer microscope have been subjected to hard wear and actual use for over five years as a testing procedure, the announcement states. The new stand of the microscopes, made of aluminum to reduce weight by 1/3, has been proven to give increased strength and twice the rigidity. Tests approximating 20 years' wear revealed less than .2 micron backlash in the redesigned micrometer screw fine adjustment.

A new tension adjustment makes it possible to set coarse focusing and substage controls for as easy or as stiff operation as desired. A new attached illuminator, optional, provides permanently adjusted illumination that fills the field of all objectives from the low "finder" to the oil immersion with refocusing the condenser.

CATALOGUES RECEIVED

Corning Glass Works, Corning, New York, has issued two bulletins, B-83 "Properties of Selected Commercial Glasses" and B-84 "Manufacture and Design of Commercial Glassware".

Bulletin 83 contains information on mechanical properties, thermal stresses, heat transmission, electrical properties, corrosion resistance and viscosity data. The booklet contains several tables and line drawings for illustration and includes a temperature conversion table.

Bulletin 84 presents background material on melting, blown glassware, blowing glass, blown glassware design, pressed glassware, pressing glass, pressed glassware design, tubing and rod, multiform process, annealing and tempering, secondary operations, sealing components together, glass and metal assemblies and metallized glass assemblies. The booklet is well illustrated with line drawings showing various steps of operation and also shows the finished product.

The Duraloy Company, Scottdale, Pa., has published a four-page folder devoted to its high alloy castings. Descriptive material is given concerning corrosion-resisting castings, heat-resisting castings and centrifugal castings.

A line drawing showing design stress curves for Duraloy alloys is shown and a table lists Duraloy characteristics and applications.

Red Devil Tools, Irvington 11, N. J., has published No. 20 catalog featuring its tools, machines and specialties.

There are seven sectional divisions devoted to 1) Glaziers' Tools, 2) Painters Tools and Cutlery, 3) Wood and other Hand Scrapers, 4) Paint Conditioners, 5) Auto Specialties, 6) Floor Polishers, Sanders and Edgers, 7) Hardware Specialties and Machines.

In the new catalog the following tools and machines are included for the first time: A new "blue tip" glass cutter with scientifically designed wheel, carboloy glass and masonry drills, new quality knives and wall scrapers, and electric paint paddle, etc.

Illinois Testing Laboratories, Inc., 420 N. LaSalle St., Chicago 10, Ill., has prepared an 8-page information bulletin, No. 2451-C, featuring its Alnor Distant Reading Electric Thermometers. The bulletin shows how to obtain unusually accurate temperature readings between minus 100 deg. F. and plus 400 deg. F. on points up to 1000 feet distant.

The bulletin describes in detail every size and type of Alnor distant reading thermometer, enumerates the services for which each type is best suited, gives installation and operation instructions, and lists the prices for every instrument.

AFTER THE SALE IS OVER...

It's *Your* MIXER

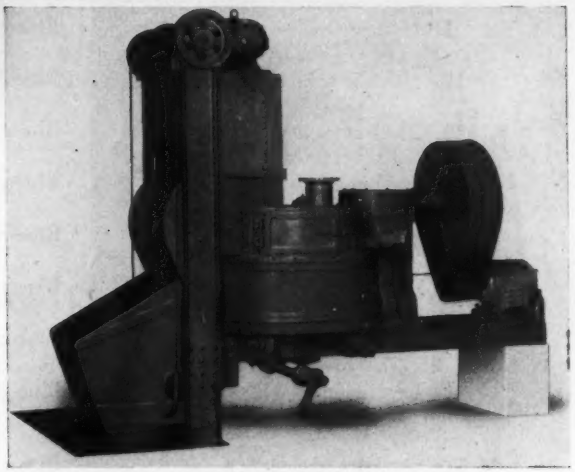
But *We're* Still Interested!

It's

"Lancaster's" Policy

to Provide

Prompt Mixer Service



"Lancaster" Mixer—Symbol EAG-3
Standard closed pan type with elevator hopper.

When you buy a "Lancaster" Mixer, it's your property . . . your dependable tool for rapid, precise batch mixing . . . but if it occasionally needs service—then, it's our concern.

No "Lancaster" Mixer ever becomes a "stepchild" . . . forgotten by its maker. Prompt and careful attention to all maintenance requirements is an established company policy to keep "Lancaster" installations operating at peak efficiency.

That's one of the reasons why "Lancaster" Mixers improve production . . . keep costs low. Write today for free literature. No obligation.

The ABC of "Lancaster" Mixing

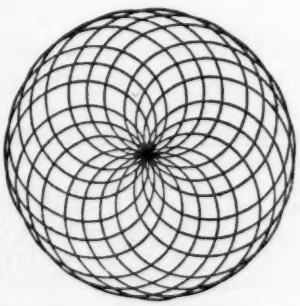


Diagram A

These curves clearly illustrate the paths covered by mixing tools during one revolution of the pan.

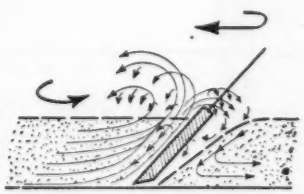


Diagram B

The stationary bottom plow is shown turning material around its horizontal axis, in waves, bringing bottom layers to the top.

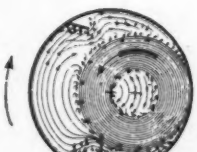


Diagram C

Material is conveyed by clockwise rotation of mixing pan and deflected by stationary sidewall and bottom plows into the path of mixing tools rotating counter-clockwise off-center of pan diameter.

POSEY IRON WORKS, INC.

formerly LANCASTER IRON WORKS, INC.

LANCASTER, PENNA., U. S. A.

Table I

Physical Properties of the Arabic Glass Weights and Stamps

Group	Glass No.	Type Date	Color	Index of Refraction	Apparent Specific Gravity	Weight, Grams	Notes
A	1	½ dinar coin weight 709-714 A.D.	Blue-green	1.512	2.494	2.1103	
	12	20-qirat coin weight 720-734 A.D.	Blue-green	1.512	2.477	3.9935	
	139	24-qirat coin weight Probably early 8th cent.	Blue-green	1.512	2.446	4.7690	Very seedy
	71	19-kharrubah coin weight 759-760 A.D.	Blue-green	1.512	2.467	5.2540	
	176	⅛ qist vessel stamp Probably early-middle 8th cent.	Blue-green	1.512	2.445	9.1282	
	3	¼ qist vessel stamp 709-714 A.D.	Blue-green	1.512	2.453	9.6105	
	75	qist vessel stamp 759-760 A.D.	Blue-green	1.512	2.474	19.2599	
	34	1 ratl ring weight 740-741 A.D.	Blue-green	1.512	2.432	85.6290	Stones Chemical Analysis
	53	½ ratl disk weight 754-775 A.D.	Blue-green	1.512	2.430	88.3368	Stones
	94	ratl ring weight 773-776 A.D.	Blue-green	1.512	2.445	123.9397	Stones
B	95	1/3 dinar coin weight 775-778 A.D.	Amber	1.512	2.512	1.4200	
C	104	¼ qist vessel stamp 780-781 A.D.	Olive-green	1.511	2.327	8.7729	Stones Red clay on surface
D	196	illegible vessel stamp Probably early-middle 8th cent.	Pale green	1.525	2.520	7.857	Weathered Chemical analysis
	164	illegible ring weight 8th cent.?	Pale blue	1.526	2.503	79.0054	Badly weathered
E	107	dinar coin weight 808-810 A.D.	Deep blue	1.528	2.546	4.2525	
	132	dirham coin weight Probably late 8th, early 9th cent.	Deep blue	1.529	2.560	2.1962	Weathered

much like Group A in basic composition, differing chiefly in the absence of copper and in the use of carbon or sulfur to produce the amber color.

C) Vessel stamp No. 104, whose index of refraction, 1.511, is very close to that of the major group, has a much lower specific gravity, 2.327. This is a significant difference, indicating a glass composition dissimilar from that of A, because the glass has relatively few seeds. It is also olive-green in color as opposed to the more common blue-green. This difference would not have been detected, had only the index of refraction been measured. Dr. Miles assigns a late 8th century date of 780-781 A.D. to this vessel stamp. It might be that the change in composition is atypical, but if it were found to be characteristic of the late 8th century weights, it could indicate a change in formula due to differences in the raw materials used, the whim of the overseer, or a shift to a different glass factory than had previously made the weights. This stamp had red clay in its crevices, while the other stamps and weights all showed traces of having been buried in yellow clay. A microscopic examination of this red clay showed that it contained chalcedony and calcite. A grain of chalcedony with some calcite intermixed was also trapped on this stamp. The red clay would appear to have come from a region of limestone outcrops, of which there are many in Egypt, and chalcedony is frequently found in the limestone. These differences are enough to suggest that this vessel stamp came from a source other than that of the rest of the blue-green series. If one had a good knowledge of Egyptian clays, he might be able to locate the source of this vessel stamp.

D) Two of the glasses showed considerable weathering. The one, No. 196, was the vessel stamp that Dr. Miles originally submitted for analysis because the in-

(Continued on page 518)

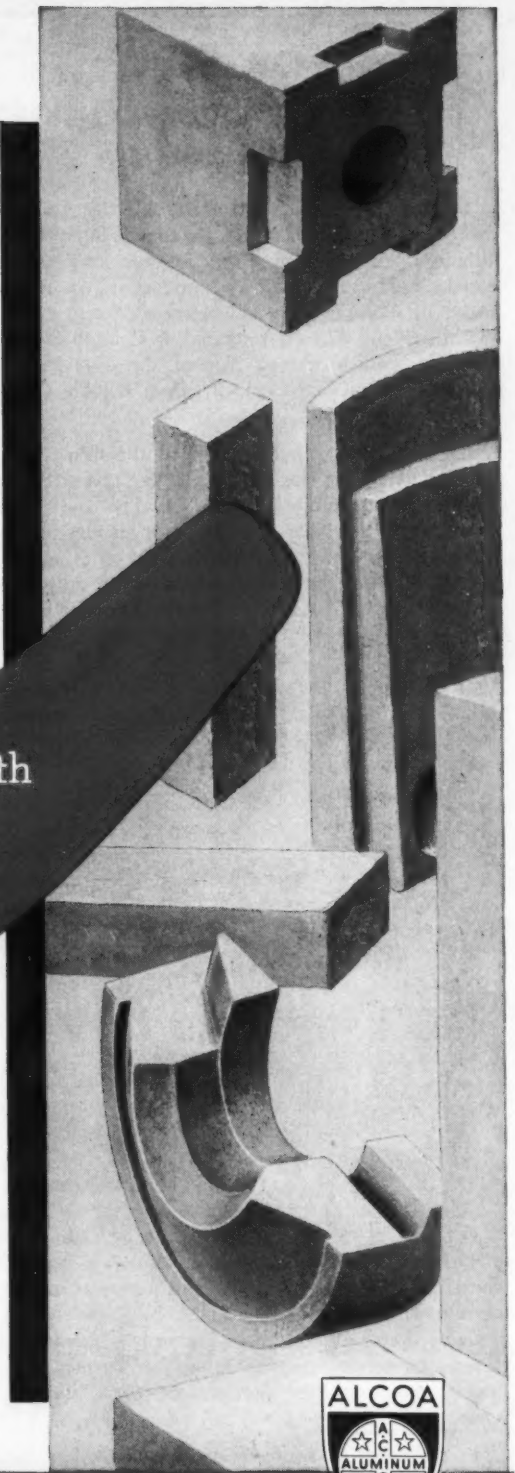
Refractories fortified with ALCOA Alumina help operators increase the output of metallurgical furnaces, chemical-processing kilns, glass tanks and other high-temperature equipment. Higher operating temperatures can be sustained over longer periods . . . down time is reduced.

Even at moderate temperatures, a *little* ALCOA Alumina in refractories makes a marked difference, but the *higher the alumina content*, the *better the performance!*

Refractory-type ceramics made with ALCOA Alumina have these money-saving characteristics:

- **Strength and stability under load at high temperatures**
- **High resistance to spalling, abrasion and fluxing at high temperatures**
- **Low coefficient of expansion**
- **High resistance to thermal and mechanical shock**
- **High resistance to corrosive slags and gases**
- **Negligible porosity and shrinkage**

refractories fortified with ALCOA Alumina have extra high-temperature stability



To meet the requirements of higher operating temperatures, manufacturers are fortifying their refractory mixes with more and more ALCOA Alumina. It's a sure way of improving performance.

If you are interested in *better* refractories, let us discuss with you the data we have, concerning the value of alumina in this type of ceramics. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 1467J Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA

ALCOA CHEMICALS

ALUMINAS AND FLUORIDES

ACTIVATED ALUMINAS • CALCINED ALUMINAS • LOW SODA ALUMINAS • TABULAR ALUMINAS • HYDRATED ALUMINAS
ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE

FOR SALE

GLASS PLANT, CHICAGO HEIGHTS, ILLINOIS

By order of the United States District Court for the Northern District of Ohio, Western Division, Owens-Illinois Glass Company offers for sale as a unit all real estate, buildings, machinery, production equipment (not including molds), tanks and furnaces (except experimental machinery and furnaces) located at Chicago Heights, Illinois, and which were a part of the assets acquired by Owens-Illinois Glass Company from Kimble Glass Company on July 1, 1946.

In accordance with the order of the Court such property is offered for sale for cash to any purchaser approved by said Court, subject to prior sale, at the fair market value of said property as a glassware manufacturing plant, as determined by an appraisal made by The Lloyd-Thomas Company, which said appraisal has been duly filed with the Clerk of said Court at Toledo, Ohio., where it may be inspected. Additions and improvements made to the property described above since July 1, 1946, and prior to consummation of sale are not included in the appraised value aforesaid but are offered for sale as a part of the unit for an additional consideration equal to the cost thereof to Owens-Illinois Glass Company.

In connection with the sale of the property and additions and improvements thereto above described, Owens-Illinois Glass Company will assign or cause to be assigned to the purchaser thereof for the consideration hereinafter set forth, all its rights in and to the following machinery and equipment leased from Hartford-Empire Company situate on said premises on July 1, 1946, to-wit:

4—4 head I S machines with feeders, revolving tube drives and motors, and variable speed drives and motors

1—5 head I S machine with same

2—36" x 74' lehrs, gas fired with top vertical discharge, motor driven steel plate exhaust fan, and all regular equipment

The consideration to be paid by the purchaser to Owens-Illinois Glass Company for the assignment of its rights in the leased machinery aforesaid shall be cash in such an amount as will reimburse Owens-Illinois Glass Company for a fair proportion of any and all payments made in connection with said leased machinery by Kimble Glass Company or Owens-Illinois Glass Company which may be considered as costs of installation, advance payments for minimum annual royalties, license fees, parts, insurance and taxes.

In the event of such sale, possession will be delivered not later than six months after the consummation of such sale to a purchaser approved by the said Court.

Address all inquiries to

Owens-Illinois Glass Company
Attention: F. G. Morfoot
P. O. Box 1035, Toledo 1, Ohio

GLASS STANDARDS . . .

(*Continued from page* 516)

scription was illegible. The other, No. 164, was a pale blue ring weight whose surface was so deeply pitted and spalled that no trace of the original surface and inscription remained. Both the index of refraction and the apparent specific gravity were sufficiently greater than in the preceding groups to confirm the visual evidence of weathering as indicative that these glasses were made from batch formulas different from the others. The chemical analysis of No. 196 shows the great difference in the glass composition from that of Group A.

E) The two deep blue coin weights made later than the other pieces examined had a slightly higher index but quite an increase in specific gravity compared to Group C. This is certainly indicative of a difference in glass composition other than the addition of cobalt to deepen the blue color.

Therefore, it would appear that at least four different glass compositions were used in manufacturing the weights and stamps studied. Similar tests on a larger series would be desirable.

The Arabic glasses that were thin enough to transmit light were examined under a polaroscope. All of the pieces showed considerable strain, the area of greatest concentration being around the raised rim of the coin weights and vessel stamps. Two specimens contained internal cracks. All of the pieces were doubtless cooled quite rapidly after being stamped.

FALL PROGRAM ANNOUNCED BY N. Y. METROPOLITAN A.C.S. SECTION

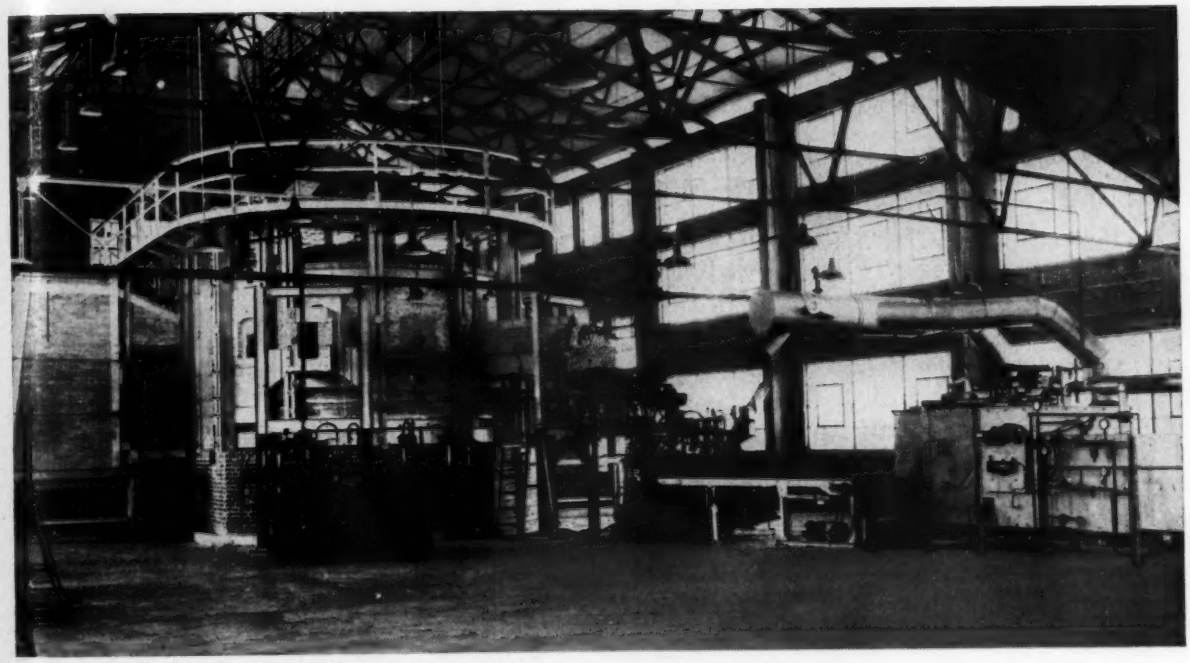
The New York Metropolitan Section of the American Ceramic Society has announced its Fall Program scheduled to start with a "Grinding Symposium" on October 14. Papers, demonstrations and panel discussions will be given by W. H. Withington, Hardinge Company; C. H. Kidwell, Reduction Engineering Company; H. F. Kleinfelt, Abbe Engineering Company; and H. Rosenbaum, Micro Techniques, Inc.

The second meeting to be held will be November 18, and speakers for the evening will be Otto R. Stach, Carborundum Company, whose subject will be "Study of Refractories at High Temperature", and Howard Christensen, Bell Telephone Laboratories, who will speak on "Electron Microscope Study of Sintering in Mixed Oxide Bodies". The January 13, 1950 meeting will feature Allan Wheeler, Titanium Alloy Mfg. Division of National Lead Company, speaking on "Technical Survey and Commercial Trends in the Titanium and Zirconium Field", and R. J. Bondley, General Electric Company, speaking on "Metal-Ceramic Brazed Seals". V. H. Remington, B. F. Drakenfeld & Co., Inc., will present a talk on "Survey Glass Decorating and Enameling Techniques" and a technical representative of Corning Glass Works will speak on "Photo-Sensitive Glass" at the meeting scheduled for February 24, 1950.

• George E. Gilliam will manage pyrometer supplies sales nationally for Brown Instruments Division of Minneapolis-Honeywell Regulator Company, it has been announced. Mr. Gilliam has been with the company for the past five years.

DESIGN
ERECTION
OPERATION

Another example where unit responsibility pays dividends



AMCO Installation During Construction Period . . .

AMSLER MORTON
CORPORATION
Chamber of Commerce Bldg., Pittsburgh 19, Pa., U.S.A.

LOW COST THROUGH HIGH QUALITY . . .

(*Continued from page* 503)

cedure similar to that described, and not to apply statistics until the shop's "know-how" is clearly inadequate to attain the objective. In the particular instance described, the annual saving in inspection cost is about $50,000. Similar savings have been effected and are being effected in other plants in the division, and in other sections of the same plant. Thus we have succeeded in breaking through the vicious circle by effecting savings on one job before requesting funds to improve another.

At the same time that this reduction in inspection cost was being attained, there was a real improvement in the post-inspection quality level. This was revealed in the direct customer contacts made by the manager of quality control. It showed up in the periodic check inspections which are made on packed stock in the warehouse. The results in terms of post-inspection cost and quality improvement for the same plant for the same period are shown in Figure 3. Here the cost scale on the left is the same as in Figure 2. The dotted line is a reproduction of the combined average inspection cost appearing in Figure 2. The scale on the right is the per cent of perfect product after inspection, and the solid line shows how this has improved. The top line represents 100 per cent perfect quality. The bottom line is not zero performance but is approximately the post-inspection quality level attained by the industry as a whole in the postwar period. The middle line was our original quality objective.

The chart speaks for itself. As inspection cost has gone down, post-inspection quality has gone up. It shows that the best way to attain and maintain quality is to make the product right in the first place, rather than try to introduce quality by inspection.

Limitations of the System

A note of warning is appropriate at this point. The particular product involved in the project described is one whose immediate past history was a good indicator of the fact that present quality could be attained. This was proved to be so by thorough investigation. In other cases where this was not so, quality has gone through abrupt changes from time to time. On products whose quality varies in this way, classified sampling is not a safe procedure for improving quality control. For products whose quality remains fairly constant, or when it does change usually changes more gradually, classified sampling is a safe procedure and inspection cost analysis provides powerful incentives for obtaining low cost through high quality.

Conclusion

In conclusion, let me summarize the five main points of this discussion: 1) The time of the quality control men in the organization should not be crowded with daily responsibilities. 2) Quality control administrators should have access to the direct line of authority, but should rarely have to use it. 3) New techniques and methods should be introduced by evolution rather than by revolution. 4) Classified sampling and inspection cost analysis can provide adequate quality assurance, make inspection cost sensitive to pre-inspection quality, and provide powerful incentives to improve quality at the source for many products. 5) Improvements in quality control can effect savings of tens of thousands of dollars annually in inspection costs.

OPTICAL SOCIETY TO HOLD THIRTY-FOURTH ANNUAL MEETING

It has been announced that the Thirty-Fourth Annual meeting of the Optical Society of America will be held at the Hotel Statler, Buffalo, New York, on October 27, 28 and 29, 1949.

The Symposium on Microscopy will include the following topics: "The Optical Microscope as Seen by a Designer" by L. V. Foster, Bausch & Lomb Optical Company; "The Optical Microscope as Seen by a User", Peter Gray, University of Pittsburgh; "Microscope Imagery and Interpretations", H. Osterberg, American Optical Company; and "Microspectrophotometry", John Loofbourow, Massachusetts Institute of Technology.

In addition to the above Symposium, invited papers will be presented as follows: "Electron Microscopy", L. Marton, National Bureau of Standards; "Infrared and Raman Spectra of Crystals", Donald F. Hornig, Brown University; "Analysis of Segregates in Alloys", J. Convey, Canadian Bureau of Mines; "Spectrochemical Research in the Union of South Africa", A. Strasheim, National Physical Laboratory, Pretoria, South Africa; "The Eye and the Camera", George Wald, Harvard University; and "High Precision Measurements with Simple Equipment", A. C. S. van Heel, Technical University, Delft, Holland.

ROSS COFFIN PURDY AWARD PRESENTED

Dr. Herbert Insley, Chief of the Mineral Products Division of the National Bureau of Standards, and Dr. F. P. Hall, Assistant Director of Research of the Onandaga Pottery Company, were presented with the Ross Coffin Purdy Award of the American Ceramic Society.

The first to be so honored, Drs. Insley and Hall were cited for their outstanding contribution to ceramic literature as the authors of the book "Phase Diagrams for Ceramists".

AMERICAN POTASH SIX-MONTHS REPORT

American Potash & Chemical Corporation reported that net income for the three months ended June 30 amounted to $406,319, or 64¢ per share on the Class A and B stocks, compared with $391,412, or 61¢ per share for the three months ended March 31.

Sales for the three months ended June 30 were $3,074,496, compared with $3,530,642 for the first quarter of 1949. Net income for six months ended June 30 was $797,732, or $1.25 per share on the Class A and B stocks, compared with $941,934, or $1.52 a share for the first six months of 1948.

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Yes, the label will last as long as the package when they're made with Glass Colors By Pemco. Permanent, fused to glass labels that continue to emphasize the manufacturers trademark, slogan or name long after the contents of the container is used offer an added sales help that is indeed a factor in today's competitive market.

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PEMCO CORPORATION

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COLOR DIVISION

BONDED REFRACTORIES FOR SPECIAL PURPOSES . . .

(*Continued from page* 499)

electrically fused and cast mullite refractories in glass furnaces. Remember, special refractories will take a lot of punishment, but when used as first-aid to the ailing furnace, they won't prove a cure-all for poor furnace design, improper burner alignment, dusty batch charging or make up for the incompetent operator. Above 2700°F any increase in furnace temperature takes a heavy toll on all refractories. The damage which becomes readily apparent in the refractories may be due to higher temperature, increased pull, high furnace pressure, slag attack from salts or basic oxides which are present in the ash from fuel oil, alterations in batch composition or in changes made in batch ingredients in order to substitute for scarce raw materials, etc. When the refractories engineer is called in, treat him fairly and provide him with all of the facts and operating data needed to enable him to study the problem intelligently.

We are fortunate to be operating in the U. S. where such a variety of top quality raw materials are available for the manufacture of refractories, with large sums of money spent each year for research and development of new products or means by which improvements can be made in those now in general use.

This is not the recommended manner in which silica and aluminum silicate refractories should be tied in at the port jamb or breast walls. Fig 43. In the presence of batch dust or vapor, a reaction will occur between silica and aluminum-silicate refractories, at furnace temperatures. Don't put silica brick on top of any mullite or alumina bearing refractory tuckstone or port sill at the base of a breast or port wall. It makes a pretty seal when the tank is cold, but it's a trouble maker in service. If you must seal such a joint, use brick of same composition as adjoining refractory.

Soda deposited on the hot face of silica brick reacts to form a liquid which will run down on the aluminum-silicate refractory. Further reaction with alumina from the aluminum-silicate refractory produces a glass which Insley has found to be this approximate molecular composition $Na_2O\ Al_2O_3\ 1\ 5\ SiO_2$. Any excess of alumina over that which is required to form a liquid of this approximate composition will crystallize out as corundum. The heavy crust of corundum which builds up on high alumina refractories in glass furnaces will serve as a partial barrier against further attack by soda. This is the pink to purplish crust which is observed on the working face of aluminum-silicate refractories after service.

Fig. 44. Better construction is obtained if the silica is eliminated and the aluminum-silicate refractory is used for the complete wall, including the port jambs.

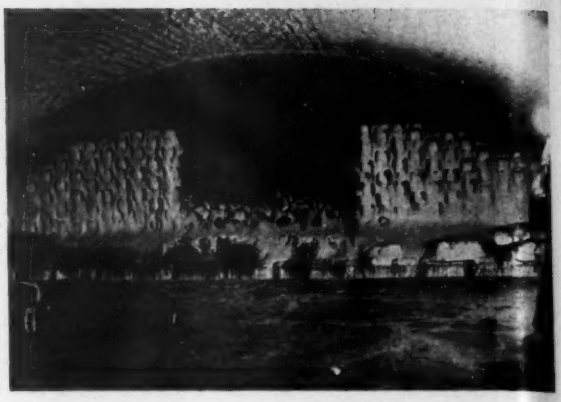

Fig. 45. Abuse of silica shadow wall in oil fired end port container tank.

Here is a much better way to do this job. Fig 44. Either use a straight or ship-lapped joint between the silica and the alumina bearing refractory or eliminate the silica entirely. Actually, you save very little by using silica brick to fill in breast walls or end walls between mullite port jambs, etc.

Here is the case of a man who lost his silica shadow wall and then probably delivered unto the tank block salesman some choice remarks about the poor quality of blocks supplied on his last order. Fig. 45. Note how the clay bridge wall cover blocks have been gutted by the wash from the silica brick. This is probably a case of expecting a 35 ton end port tank to melt 100 tons per day, requiring a hot nose end; possibly a poorly adjusted oil burner or oil carrying appreciable soda, vanadium or manganese dioxides in the ash, more likely some of all three. Essentially, this is NOT a refractories problem. This plant needed either one less bottle salesman or bigger tanks.

Conclusion

Bonded special refractories are being used successfully and economically in glass furnace construction and maintenance. A working knowledge of the properties of the several refractories, and the limitations of the forming methods or processes by which refractories are made, will help the glass plant engineer to make a selection of the materials required for the furnace and the feeders.

The author wishes to express appreciation to the men in the glass industry whose interest and cooperation made it possible to include many of the facts and nearly all of the photographs which appear as a part of this paper.

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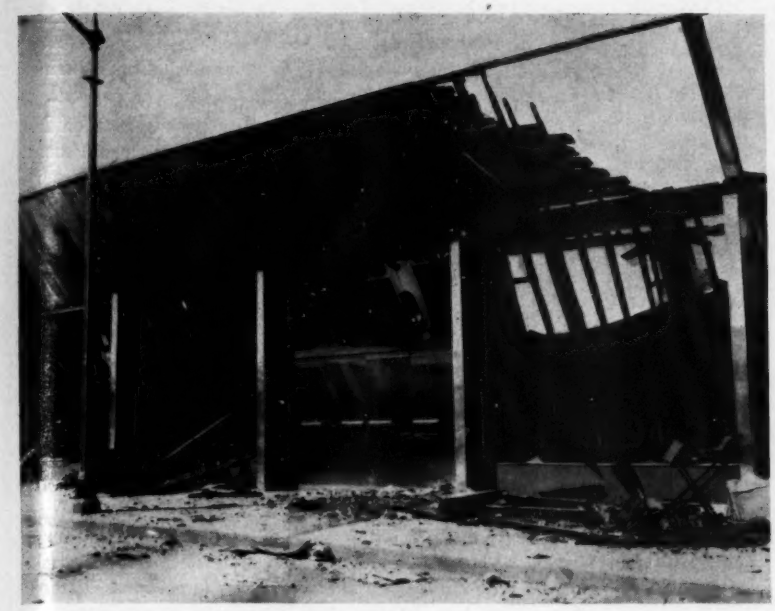

Only the Tuf Flex doors and a few steel uprights remain standing after a half-million dollar fire which recently gutted the Lucky Super Market in San Bruno, California. The doors were heat-tempered by Libbey-Owens-Ford Glass Company to provide resistance to impact and temperature shock. The store was designed by Raymond Loewy Associates and featured entire walls of plate glass. The fire originated in the stockroom and burned with intense heat for more than two hours.

DIAMOND ALKALI PROMOTES TWO EXECUTIVES

The Diamond Alkali Company has announced the advancement of Earl J. Mills and Charles W. Klaus, effective immediately.

Mr. Mills has been appointed Manager of the company's Southwest Sales District, which embraces Texas, Oklahoma and Kansas, following two and one-half years as manager of less-carload sales at the firm's Chicago sales office. Associated with Diamond Alkali for 17 years, Mr. Mills was formerly associated with Lever Brothers Co.

Mr. Klaus, who now takes complete charge of Diamond sales activities affecting the seven-state area of Illinois, Indiana, Iowa, Michigan, Minnesota, Wisconsin and Nebraska, was formerly associated with what was then the Benner Chemical Company for 17 years. Ten years later, he became Secretary of the company, a post he held until 1947 when he became Manager of carload sales for Diamond.

ANCHOR HOCKING APPOINTMENTS

Wm. V. Fisher, President of Anchor Hocking Corporation, has announced the promotions of W. B. Snell, Jr., W. R. Bone and G. F. Miller to General Manager in Charge of Manufacturing of the Package and Tableware Divisions, General Factories Manager of the Package Division and General Factories Manager of the Tableware Division, respectively.

Mr. Snell has served as General Factories Manager of the corporation's Tableware Division for the past twelve years, following twenty-eight years in container production. Mr. Bone joined the firm in 1938 and has served both the Package and Tableware Divisions. For the past five years he has been Manager of the Salem, N. J. plant. During his association with Anchor Hocking since 1931, Mr. Miller has been Plant Manager, Manager of the firm's Plant No. 2 and Plant No. 1.

SURFACE COMBUSTION APPOINTS DIVISION SALES MANAGER

The appointment of Theodore F. Loughry as Sales Manager of Surface Combustion Corporation's Gas Production Division, has been announced by C. B. Phillips, Vice President in charge of Sales. Mr. Loughry will make his headquarters in Toledo.

With Surface Combustion since 1924, Mr. Loughry, after service with several utility firms, transferred to the New York office as district industrial sales manager in 1934. When the firm began making gas catalytic cracking units, he was assigned to handle sales.

PROPOSED TRADE PRACTICE RULES FOR WHOLESALE OPTICAL INDUSTRY

The Federal Trade Commission has made available to all interested and affected parties proposed trade practice rules for the wholesale optical industry and has announced a hearing to be held September 1.

O. HOMMEL MAKES TWO APPOINTMENTS

The O. Hommel Company has announced the appointments of Edward H. Rollfs to the firm's Frit Division, Eastern Sales and Service District, and Lyle A. Holmes to the Color and Pottery Frit Division in the Canadian and Midwestern territory.

Mr. Rollfs was formerly associated with the Florence Stove Company and then was with the USAAF to serve as a mechanical engineer at Ford's River Rouge plant. Prior to joining The O. Hommel Company, he was Production Manager of the Hanson Porcelain Enamel Company.

Mr. Holmes is a graduate of the University of Saskatchewan with a B.S. in Ceramic Engineering. Following his discharge from the Corps of the Royal Canadian Engineers, he was employed by Sovereign Potters at Hamilton, Ontario, as a ceramic engineer, after which he joined the Hommel company.

RESEARCH DIGEST . . .

(*Continued from page* 509)

is 1.25 that which would have been required if the mean level had remained unaltered throughout the life of the tank with a standard deviation of ± 0.25 in.; that is to say, a 25 per cent increase of life has been obtained without reducing the accuracy of level control. When the relative life as estimated from the time taken to reach a constant thickness at the point of maximum attack is plotted against the standard deviation of glass level, the resulting curve shows that even a very small deviation of the order of 1/10 inch gives a 20 per cent increase in life.

With increasing temperature gradients, the total amount of block dissolved is very much reduced the greater the gradient, but the life of the block which is determined by the thinnest part of the block is unaltered. The most striking effect of greater temperature gradients (which in many cases is due to increased iron content of the glass) is on the life of the bottom blocks and on the relation between the life of the bottom and side walls. The greater the temperature gradient (or the higher the iron content), the longer the life of the bottom blocks will be.

When the melting temperature of the tank is raised, the reason may be that better quality glass is desired or, on the other hand, a greater output of glass of the same quality may be wanted. In the first case, the result of the increase in temperature will certainly be to increase the iron-oxide content of the glass and, hence, steepen the temperature ingredient. In the second case, the iron oxide content may be unaltered because although the rate of solution of the refractory is increased, the time during which the glass is in contact with the block is reduced.

The effect of temperature on life was illustrated by comparing the time taken to get down to a thickness of 2 inches at the point of maximum attack. This is shown below:

Temperature °C	*Relative life*
1300	5.40
1350	3.07
1400	1.80
1450	1.00
1500	0.66

In these calculations, no account has been taken of cooling on the outside of the blocks. Such cooling will begin to have a marked effect on the inside surface temperature of the blocks when the thickness becomes small and the rate of solution will be reduced. This will tend to level out the difference between the attack at the flux line and at lower levels and also to make the "cut in" at the flux line less steep.

Different kinds of block have not only different rates of solution at a given temperature, but also differences in the slope of the curve relating temperature and solution. For that reason, this method of deducing the contour of the block after use is of great value for comparing different blocks.

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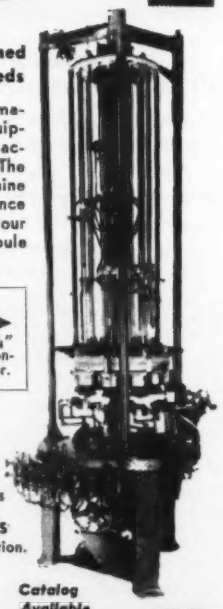

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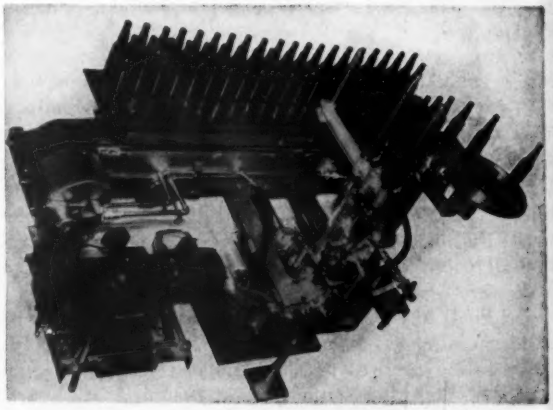

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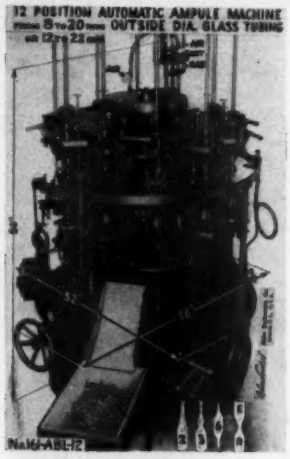

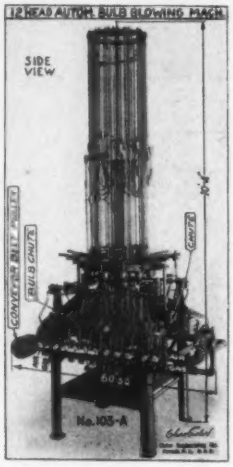

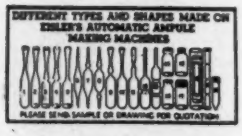

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GLASS CONTAINER SALES RETURNING TO SEASONAL PATTERNS . . .

(*Continued from page* 500)

Pattern" covers the years 1946, 1947 and 1948.

Reviewing this latter chart, it is pointed out that during 1946, 1947 and the first half of 1948 when there was still a shortage of container and production materials going into the manufacture of containers and overall container demand had not yet been completely met, actual glass container shipments continued in a fairly steady volume not affected by what had previously been the normal seasonal slowdown during the winter months. The two sharp rises indicated in shipments during 1948 for purposes of clarification are explained as periods of stimulated sales due to pending price increases in the end product. During the last half of 1948, it is clearly shown by the chart that glass container shipments reverted for the first time since the war to the previously established preware seasonal pattern of 1935-1939. Although the May and June glass container shipments were not received in time to graph them onto the chart, later information discloses that, in keeping with the established prewar seasonal pattern, an increase in shipments over April occurred in May and again in June.

Another interesting fact uncovered by the study, as shown in the chart "Average Monthly Stocks on Hand and Operating Equivalent in Weeks", indicates that the glass container industry is approaching its prewar operating turnover ratio. It should be noted that prewar

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stocks equalled approximately 9 weeks of the 1936-1939 average annual production, but because of increased consumption, an almost 20 per cent larger inventory represents less than 6 weeks production based on 1949 first quarter production.

TELEVISION DEVELOPMENT BY PITTSBURGH PLATE GLASS COMPANY

An important development in television glass that will provide for the first time sharp black and white contrast pictures without dazzling brightness and which may be viewed equally well in daylight and artificially lighted rooms has been announced by D. C. Burnham, Vice President of Pittsburgh Plate Glass Company.

The glass, known as Teleglas, is to be used in the faces of metal picture-tubes and makes possible the maintenance of an approximate 35-to-1 contrast under widely varying conditions of room light. This means that the highlights of the pictures when viewed with surrounding illumination would be 35 times brighter than the darkest shade obtainable. Teleglas acts as a filter to reduce the detrimental effects of room light and to minimize halation, the halos of light formed from internal reflections within the tube itself.

The new glass produces a sharp black and white picture directly on the tube face itself. It eliminates the need for costly filtering devices which were formerly placed in front of the tube in attempts to enhance contrast.

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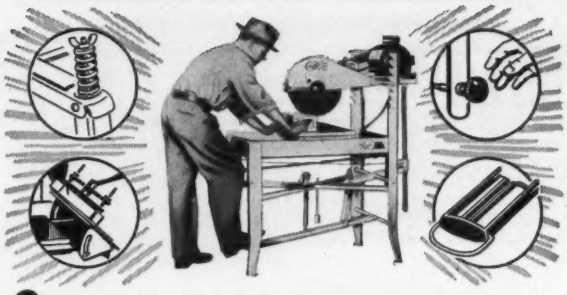

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